The Welding Engineer

Reg. U. S. Pat. Office

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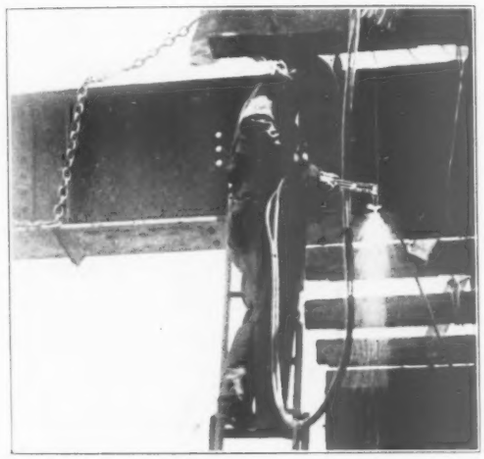
Guess Work vs. Certainty in Cutting



The TORCHWELD KLEEN KUTTER in action

To get your share of the new opportunities you've got to go after business in dead earnest; you've got to tune up your production organization to such a high pitch of efficiency that mistakes will be conspicuous by their absence.

You can't afford to overlook anything that offers aid toward these ends.

TORCHWELD WELDING AND CUTTING APPARATUS

are essentials you cannot dispense with. They have a

Wider range of usefulness.
Save their cost in a few months.
Eliminate guess work from welding practice.

TORCHWELD torches *do not flash;* use equal quantities of acetylene and oxygen—and no more; and will positively produce neat non-oxidized welds.

Inexperienced operators learn to weld with TORCHWELD apparatus very rapidly; they do not have trouble securing and maintaining a perfect neutral welding flame.

Think in Terms of the Future

Start investigating Torchweld Products NOW.
We are prepared to prove to you that ours is the BETTER WAY.

TORCHWELD EQUIPMENT COMPANY
Fulton and Carpenter Streets, Chicago
Complete welding and cutting plants—portable or generator systems

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

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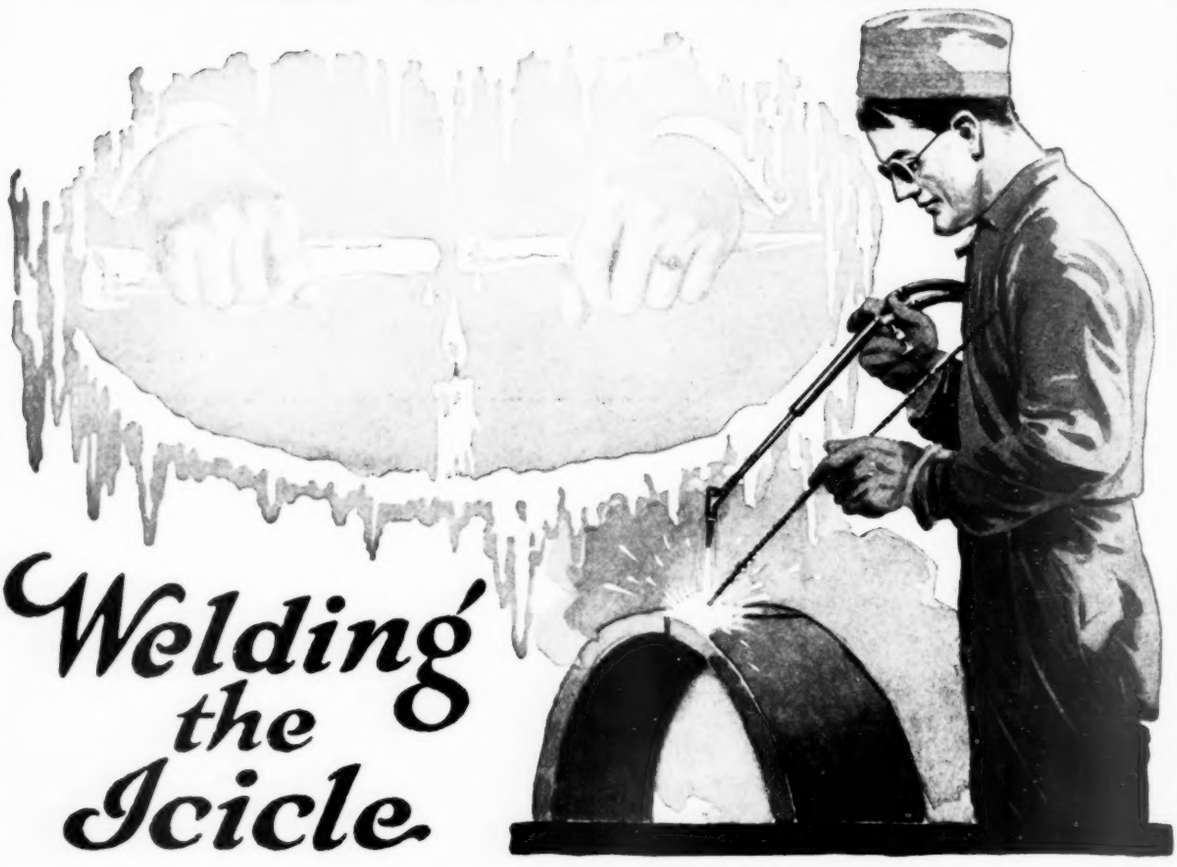
Oxweld



Welding the Icicle

BREAK an icicle some snappy zero morning; thaw the broken ends a little over a candle; then let them freeze together. . . . You have welded the icicle!

That's the way oxwelding works on broken metals.

At high temperature, metals are liquid like water at ordinary temperature. Ordinarily—at the temperature at which you use them—the metals are "frozen" solid. . . . A break occurs; you melt the surfaces of the break with the terrific heat of the oxwelding flame; you remove the flame, and the broken parts "freeze" together as before the break happened. That's oxwelding.

Every time you throw away a broken metal part at your plant you throw away that much cash. For the new part you buy is not a whit better than the old part after oxwelding. *The new part may cost you 300 dollars; the oxwelded good-as-new old part—300 cents.*

Write to us for bulletins showing the advantages of oxwelding in your industry

OXWELD ACETYLENE COMPANY

NEWARK, N. J. CHICAGO LOS ANGELES

World's Largest Maker of Equipment for Oxwelding and Cutting Metal

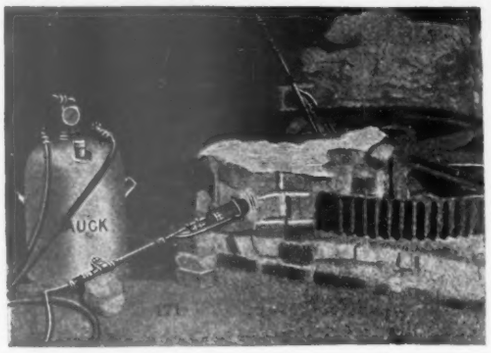
MILBURN APPARATUS

Milburn mixing principle produces best work with minimum gas, and no flash backs, burnt tips, or other annoyances.

Exceptionally durable construction of torches insures long, satisfactory service. Regulators dependable and free from valve, diaphragm and gauge troubles.

Ask for Catalogue No. 35.

The Alexander Milburn Company
Baltimore, Maryland



A Hauck Double No. 8 Burner Outfit Preheating Large Gear Wheel.

HAUCK

KEROSENE PRE-HEATERS

Pre-heating is one of the principal factors of successful welding. It is essential on cast iron or high carbon steel to prevent chills or hard spots.

Pre-heating with a Hauck Burner insures a saving of 75% in acetylene and oxygen, besides securing better welds and reducing welding time and labor.

Write for a copy of our Bulletin 93W

HAUCK MANUFACTURING CO.
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Quality—The Best
Prices—Right
Delivery—From Stock

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WELDING SUPPLIES

have been developed with the growth of the Welding Process, having been on the market since welding was in its infancy, and the constantly increasing demand for these supplies is the best testimonial that can be offered.

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Rods *Wires* *Fluxes*

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IRVINGTON, N. J.

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1 Apparatus substantially built of the best materials made. Gas and oxygen mixing and consumption guaranteed to be in correct proportions to produce the correct flame and economy.

2 All accessories and supplies of the best quality.

3 The most completely equipped welding shop in New York City and capable of handling the largest castings or any quantity of manufacturers work—men and apparatus supplied for outside work.

4 A large stock of acetylene and Oxygen always on hand to supply our trade at the lowest market prices.

5 Everything needed for oxy-acetylene work we supply.

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Incorporated
556 West 34th St., New York City

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Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Commercial Acetylene Welding Co.
Universal Oxygen Co.

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The Welding Engineer
P. F. Willis

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International Oxygen Co.
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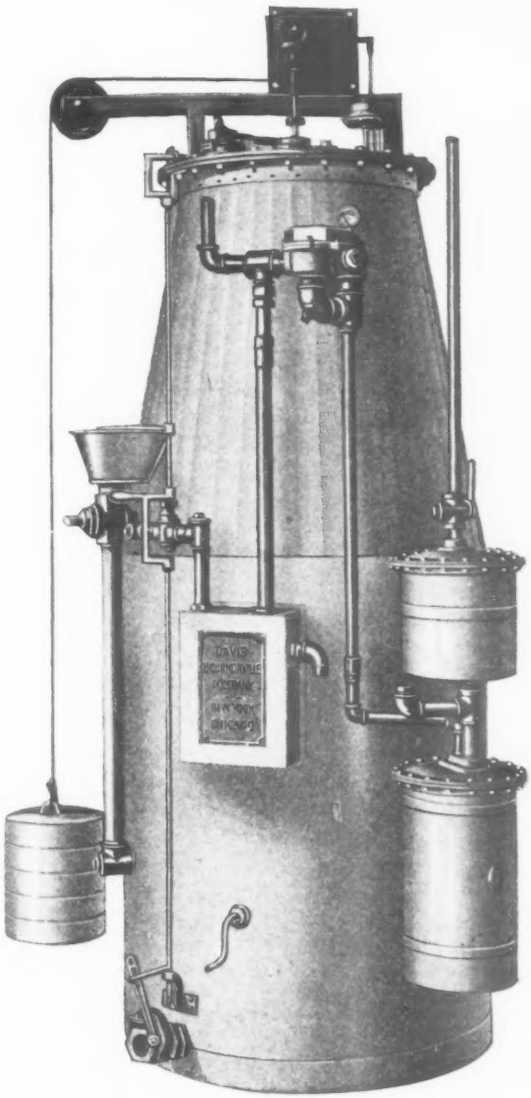

No. 300 Davis Acetylene Generator.
Height 9 ft. 7 in.; weight 1,000 lbs.

Acetylene Pressure Generation In Your Own Plant

The largest steel mills, foundries, ship yards, locomotive and car shops and sheet-metal working plants, making the most extensive use of the oxy-acetylene process in welding and cutting, for manufacturing and for repair work, generate acetylene in their own plants as it is wanted with Davis Acetylene Pressure Generators—the acme of efficiency, simplicity and economical production. Acetylene at approximately 1 cent per cubic foot, under working pressure, automatic operation, piped to any part of the plant, and no gas holders with storage of free gas.

Made in three types—stationary, portable, and two-pressure generators for combined pipe-line service and compression into portable cylinders. Stationary actylene pressure generators in five sizes:

No.	Carbide Capacity	Water Capacity	Acetylene per hour
25	25 lbs.	25 gals.	25 cu. ft.
50	50 lbs.	50 gals.	50 cu. ft.
100	100 lbs.	100 gals	100 cu. ft.
200	200 lbs.	200 gals.	200 cu. ft.
300	300 lbs.	300 gals.	300 cu. ft.

Hourly output is in accordance with the rules of the Underwriters' Laboratories of the National Board of Fire Underwriters.

Davis Generators are installed in batteries for greater requirements; many plants have batteries of from two to twelve of the No. 300 Generators. Carbide is estimated to produce from four to five cubic feet of acetylene per pound of carbide, a full charge to operate for the full working period of four to five hours.

Davis Acetylene Pressure Generators were designed specially for Oxy-Acetylene Welding and Cutting installations, and are manufactured with twenty years of experience in acetylene generation. They were the first automatic-feed pressure generators, the first on the inspected list of the National Board of Fire Underwriters, and have been in constantly increasing successful use. The list of successful users is significant—**write for it** and for detailed information and engineering service to determine the practicability of operation in your own plant.

DAVIS-BOURNONVILLE COMPANY

OXY-ACETYLENE WELDING
DAVIS
APPARATUS
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K-G Welding & Cutting Co.
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Torchweld Equipment Co.

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Air Reduction Sales Co.
Burdett Oxygen Co.

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See also "Torches."

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International Oxygen Co.
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Burdett Oxygen Co.
General Welding & Eqpt. Co.
International Oxygen Co.
Oxweld Acetylene Co.
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Southern Welding Mach. Co. .....

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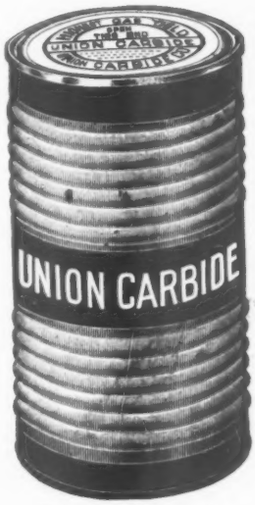
The Thermalene Co. 50
R. J. Tobin. .....
Torchweld Equipment Co. .....Front cover

U

Union Carbide Sales Co. .....
United States Welding Co. .....
Universal Oxygen Co. .....
Universal Regulator Co. .....
U. S. Gauge Co. .....

W

Willis, P. F. .....



Packed in Blue and Gray Drums

Union Carbide Sales Company

New York City, 42nd St. Building — **Chicago, Ill., Peoples Gas Building** — **San Francisco, Cal., Kohl Building**

SOLE DISTRIBUTORS OF

UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

$3\frac{1}{2}$ x 2 in. —a large size.

$1\frac{1}{4}$ x $\frac{3}{8}$ in. —an intermediate size.

2 x $\frac{1}{2}$ in. —a medium size.

$\frac{1}{4}$ x 1/12 in. —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

ALABAMA
Birmingham—1916 Morris Ave.
Mobile—16 S. Commerce St.
Montgomery—114 N. Perry St.

ARIZONA
Phoenix—42 S. Central Ave.

ARKANSAS
Fort Smith—109-123 So. Ninth St.

CALIFORNIA
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.

COLORADO
Denver—Nineteenth and Wazee Sts.

CONNECTICUT
Hartford—412 Trumbull St.

DISTRICT OF COLUMBIA
Washington—Maryland Ave. and 9th St., S. W.

FLORIDA
Jacksonville—515 W. Bay St.
Tampa—107 Madison St.

GEORGIA
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.

ILLINOIS
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—100-110 Edmund St.
Monmouth—124 E. Archer Ave.
Marion—315 S. Granite St., Box 747.
Quincy—222 S. Eighth St.
Streator—702 East Elm St.

INDIANA
Evansville—1601 Illinois St.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.

IOWA
Des Moines—117-119 Fifth St.
Dubuque—8th and Washington Sts.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 398.

KANSAS
Pittsburg—109 W. Third St.
Salina—154 So. 5th St.
Wichita—721 Beacon Building.

KENTUCKY
Louisville—126 E. Main St.
Middlesboro—1701 Cumberland Ave.

LOUISIANA
New Orleans—819-21 Julia St.

MAINE
Portland—11 Exchange St.

MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.

MASSACHUSETTS
Boston—(See Cambridge "A.")
Cambridge—241 Albany St.
Springfield—Napier St.

MICHIGAN
Detroit—Grand River and Lorain Ave.
Grand Rapids—500 Shawmut Ave., N. W.
Hancock—First National Bank Bldg.
Iron Mountain—215 E. A St.
Jackson—172 South Water St.
Saginaw—1830 No. Michigan Ave.
Sault Ste. Marie.

MINNESOTA
Minneapolis—334 N. First St.
Virginia—413 Chestnut St.

MISSISSIPPI
Vicksburg—1312 Washington St.

MISSOURI
Kansas City—1316-1318 W. Eighth St.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)

NEBRASKA
Omaha—1007-9-11 Jones St., Union Sta. P. O.

NEW JERSEY
Camden—West and Clinton Sts.
Jersey City—554-56 Henderson St.

NEW YORK
Albany—Montgomery and Colonie Sts.
Binghamton—21 Jarvis St.
Geneva—Exchange St. and Railroad Pl.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
New York.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Roscoe.
Utica—135 Hotel St.
Watertown—438 Court St.
Whitehall—22 Main St.

NORTH CAROLINA
Wilmington—Room 16 Masonic Temple, 13 N. Front St.

NORTH DAKOTA
Fargo—17 Broadway.

OHIO
Cincinnati—67 Plum St.
Cleveland—601 The Citizens' Building.
Columbus—330 Dublin Ave.
Dayton—812-828 E. First St.
Lima—338 East High St.
Toledo—414 S. Erie St.
Zanesville—Main and Second Sts.

OKLAHOMA
Oklahoma City—27-29 E. Grand Ave.

OREGON
Portland—Fifteenth and Hoyt Sts.

PENNSYLVANIA
Beaver—359 Beaver St.
Du Bois—Webber Ave. and Franklin St.
Erie—1426 Chestnut St.
E. Greensburg—Clark and George St.
Harrisburg—627 Walnut St.
Johnstown—Messenger St. & B. & O. R. R.
Pittsburgh—1202 Chamber of Commerce Building.
Pottsville—Railroad and Sanderson Sts.
Scranton—Penn Ave. and Vine St.
Shamokin—5th and Walnut Sts.
Williamsport—Canal and Court Sts.

SOUTH CAROLINA
Charleston—153 Church St.

TENNESSEE
Chattanooga—627 Volunteer State Ins. Bldg.
Knoxville—426 West Depot Ave.
Memphis—671 South Main St.
Nashville—105-107-109 Broadway.

TEXAS
Dallas—802-810 Cadiz St.
El Paso—900 E. Overland St.
Houston—Baker and Cedar Sts., Box 745.
San Antonio—Cor. Leal and N. Salado Sts.
Waco—13th and Mary Sts.

UTAH
Salt Lake City—118 W. Second South St.

VIRGINIA
Lynchburg—1324 Commerce St.
Norfolk—513 Front St.
Richmond—18th and Cary Sts.

WEST VIRGINIA
Bluefield—195 Roanoke St.
Charleston—Broad St. and K. & M. R. R.
Fairmont—"A" Street.
Huntington—820 3rd Avenue.

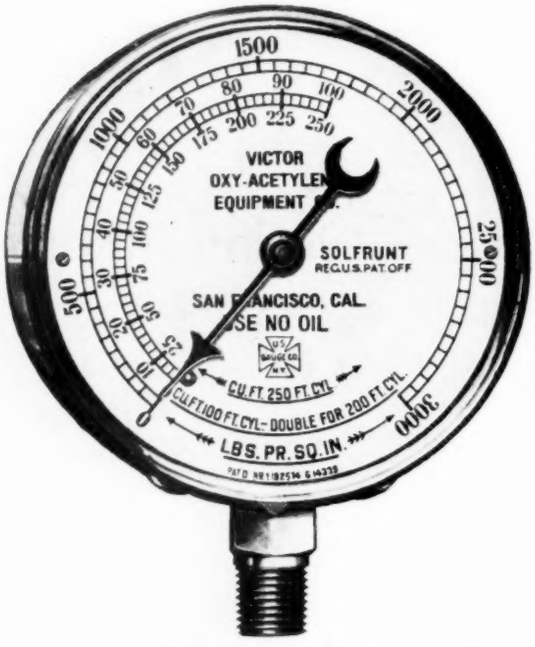
WASHINGTON
Seattle—1103 First Ave.
Spokane—646 Peyton Building.

WISCONSIN
La Crosse—Front and King Streets.
Madison—513-19 Williamson Street.
Milwaukee—120-134 Jefferson St.

We recommend our customers to **select** from the list, the **city** from which the quickest delivery and lowest freight rate can be obtained, **and address their orders to "Union Carbide Sales Company"** at the distributing point selected **accompanied by remittance.**

Please address request for information or special correspondence to either the New York or Chicago office.

SAFETY FIRST



Patented July, 1916

OXY-ACETYLENE GAUGES

for

WELDING and CUTTING APPARATUS

United States Gauge Co.

67 Wall St., New York

WORKS:
Sellersville, Pa.

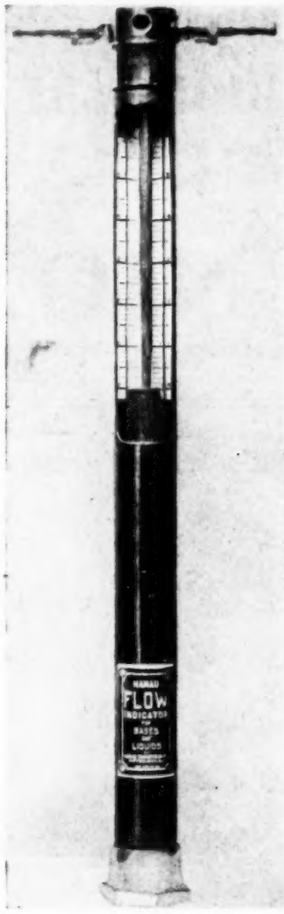
BRANCHES:

Clark St. Bridge
Chicago, Ill.

42 W. Larned St.
Detroit, Mich.

681 Market Street
San Francisco

Board of Trade
Montreal, Can.



Increase efficiency!

Improve quality of work!

Save time and gas!

Reduce the scrap pile!

Use the

"HYDREX FLOW INDICATOR"

(Pat. Pend.)

It permits to set the flame properly for each torch, tip or special work.

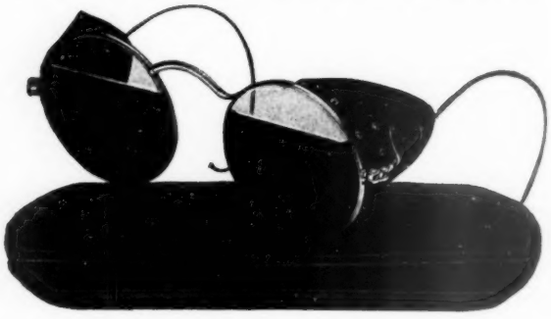
It indicates consumption of any gas by simple reading.

It is reliable, foolproof and easily applied.

Write for further information.

Hydrex Engineering Corporation
Hutchinson Bldg., Buffalo, N. Y.

Albex Bifocals



White-Smoked

Solid white metal frames, easy cable temples, leather sides and adjustable bridges.

Upper part, clear glass; lower part, gray green Hallauer glass for welding.

Per pair - - - - - - - - - - **$1.50**

Blue-White

Same frame with the upper part, cobalt blue glass; lower part, clear glass.

Each pair supplied with a strong steel case.

Per pair - - - - - - - - - - - **$1.50**

WILLIAM C. ADAMS

Manufacturer, Importer and Wholesale Dealer in

Welding Goggles and Protection Glasses

332 BOYLSTON STREET

BOSTON - - MASS., U. S. A.

Write for Catalogue. Samples Submitted.

Universal All-Steel Welding Truck

A time-saver and convenience which no progressive welding shop can afford to be without. Made in two sizes; to carry two 100 ft. drums, and to carry two 200 ft. drums.

Truck is equipped with torch hooks on which the torch can be conveniently placed when not in use, and a ten hole tip rack. The welding rod supply box is made to carry eight pounds of welding rods. The supply case, spaced off into compartments, will carry two one-pound cans of flux, cutting tips, adaptors, goggles and wrenches.

The truck has a hand wheel drum tightening device, strongly constructed, and so made that the drums are held tightly, eliminating any shaking when the truck is in motion.

The entire truck is constructed of heavy angle iron, and has a 10 gauge steel platform. It is so constructed that when fully loaded it will balance easily, facilitating rapid transportation. **WRITE FOR PRICES TODAY**

UNIVERSAL OXYGEN COMPANY : Sheboygan, Wisconsin

Milwaukee Branch, 554-556 E. Water St.

High Silicon Cast Iron Welding Rods

Atlas Quality

Also rods, wires and fluxes for welding all metals. Quality guaranteed.

Prices Cheerfully Quoted.

ATLAS FOUNDRY CO.
IRVINGTON, N. J.

OXYGEN, ACETYLENE and HYDROGEN REGULATORS

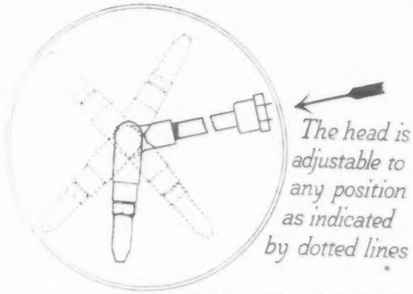
(With or without U. S. Gauges)

Approved by Board of Fire Underwriters

UNIVERSAL REGULATOR COMPANY
775-9 Communipaw Ave., JERSEY CITY, N. J.

Tobin's Adjustable Head

Operates from any position. No loss of time or gases. The nozzle may be moved into any desired position without twisting or rotating the handle or hose.



The head is adjustable to any position as indicated by dotted lines

THE TOBIN ADJUSTABLE HEAD

may be attached to any standard welding torch. It is now in successful operation on the Facific Coast, particularly on Burdett Torches. A constant and uniform flow of gas is assured—no change in your regular torch—simply more flexibility in manipulation. This torch was used on cabinet work on U. S. Destroyers in ship yards, the most inaccessible work being handled with ease. The Tobin Head is equally efficient on heavy work.

Write for prices and particulars.

R. J. Tobin 829 EL DORADO STREET VALLEJO, CAL.

No. 8-G for Natural Gas, $6.50

Preheating Blowpipes

The two most essential points in welding are:

FIRST: The use of a proper sized oxy-acetylene flame.

SECOND: The saving of gas by preheating your work for the oxy-acetylene flame.

The first is under your control in the use of the oxy-acetylene apparatus you have selected.

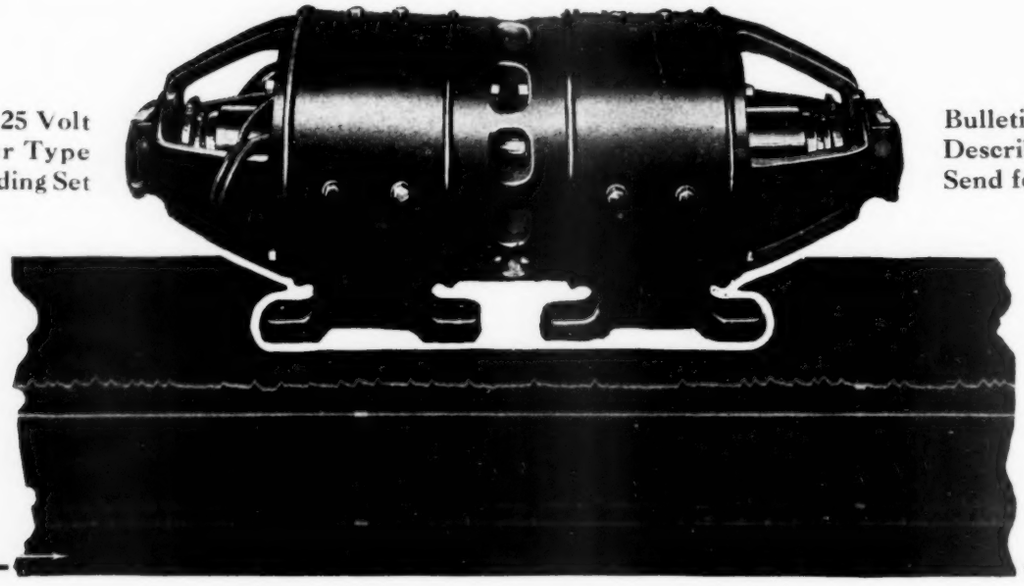
The second, we can aid you in by supplying the proper blowpipe for preheating purposes.

We manufacture blowpipes for use with Coal Gas, Natural Gas, Gasoline Gas and Acetylene Gas, with Air Blast.

Our catalog "B. X." free for the asking, contains full description and prices. WANT ONE?

Buffalo Dental Manufacturing Co.
Buffalo, N. Y., U. S. A.

3 K.W. 125 Volt
Balancer Type
Arc Welding Set



Bulletin No. 48940
Describes This Set.
Send for it.

Oscillograph curve, showing electrical conditions in welding circuit of constant energy arc welding equipment. Curve "A" shows current in arc, approximate average value 150 amps. Curve "B" shows voltage across arc, approximate average value 15 volts.

Steady Flow of Metal Assured by Efficient and Simple G-E Welders

G-E constant energy arc welding sets are used to assure a steady flow of metal into the weld and high operating efficiency.

A constant flow of metal is assured by the inherent automatic regulation of the energy in the welding circuit throughout the welding range for metal electrodes.

The distribution of welding current between the two units comprising the set and practically dispensing with external resistance in series with arc, assure high efficiency.

One small panel and the set illustrated are all the equipment needed for a one man outfit where operator has mask and electrode with flexible cable—if 125 volt direct current is available.

Consistently perfect welds are being produced in essential war industries by the use of this equipment.

We are prepared to demonstrate these sets and make good deliveries.

General Electric Company

General Office Schenectady, N.Y.

Perfect Work = Money Saved + More Work

"WELD THE WIEDERWAX WAY"

If a good mechanic were being shown a new machine, his first question would be "What kind of work does it turn out?" Next he would ask whether it would save money for him, and finally how much it was to cost him.

A machine that turns out perfect work saves money for the operator—particularly in the case of the welder. Preheating by charcoal or other agencies is uncertain at best, and troublesome.

Now then the supreme virtue of the WIEDERWAX PREHEATER is its perfect heating qualities. Its fire is soft and radiant, and evenly distributed. It may be regulated at will. Consequently all danger from fracture or warping is eliminated. Thus it saves at once, all the time and material used in re-welding pieces that have cracked.

In every shop almost, there are jobs turned away because of the difficulty of preheating. For instance the cast iron heater section, radiator sections, and castings with large flat surfaces. Enough of such work is turned down in the average welding shop, to pay for the Wiederwax Preheater within a short time. For the Wiederwax has made these sorts of jobs easy to do, and absolutely safe. Not only that, but it burns less fuel for the same amount of work and one man can do the job quite easily.

In the addition to all this, the cooling oven saves you the cost of burying materials like asbestos. It does away with charcoal fumes and dirt. It saves time and worry and fuss.

A Practical Example of Wiederwax Magic

Imagine preheating and welding this clumsy, flat panel heater on a charcoal fire. No need to remind of the difficulties to be encountered—fire broken down, uneven heat, danger of fracture and so on.

In the picture the welder is just finishing the piece. The protecting cover of sheet iron has been removed so the picture could be taken. The piece is propped and was so heated also that a good picture might be made.

This panel heater was cracked around the opening to an extent of approximately 30 inches. It was placed upon the preheater, and in one hour was ready for welding. A sheet iron covering was used to protect the operator at work and also to aid in the distribution of heat the latter purely a "shop kink." Owing to this even distribution of heat, and the gradual diminishing of temperature by first lowering the burners and then turning them out, this piece was perfectly and easily cooled just as you see it, with the exception of being covered again with a piece of sheet iron. Total heat cost $1.10, time 1 hour. One man did the job.

By charcoal it would have cost approximately $3.50 and taken two and a half hours to preheat. The saving, therefore, is $2.40 in fuel, one and a half hours in time, plus all the needed material used in the "burying" process.

In addition to this saving, you have, by reason of perfect heat and even expansion and contraction, turned out a *perfect piece of work* with *little trouble* and *no risk* whatever.

How Long Are You Going to Hold Out Against Such Proof?
Write Us Today for Our Interesting Free Booklet.

THE GEIST MANUFACTURING COMPANY

2001 ATLANTIC AVENUE ATLANTIC CITY, N. J.

PRACTICAL WELDERS

WANT TO KNOW

The Cost of Operation

OF

The Mephisto A. C. Welder

If your rate is 3c per k. w. h. your cost on average work would be under 15c per hour.

Compare this with your oxy-acetylene costs.

You can't disregard a saving of this magnitude.

A portable machine with welding current from 40 to 150 amps., with a tap for intermittent cutting. No regulating apparatus or moving parts, with efficiency of over 90%.

SEND FOR BOOKLET 600

THE ARCWELL CORP.

42 BROADWAY N. Y. CITY

C. P. R. BLDG., TORONTO, CANADA

E. M. NOONAN CO.—PHILADELPHIA
R. L. HUNTER—SEATTLE
F. H. DORNER—MILWAUKEE
STRONG, CARLISLE & HAMMOND—CLEVELAND
PHINEAS H. YORK—INDIANAPOLIS, IND.

WILLIS WELDERS

For ten years Willis Welders have stood for what is best and most efficient in welding and cutting apparatus. During this time Willis equipment has been in use from coast to coast and its dependability has never been questioned. Willis welding and cutting torches are well designed, perfectly balanced and made carefully from the very best materials.

Willis Acetylene Generators are in successful operation all over the United States. They are absolutely safe and reliable.

Send for illustrated catalog today. If you are interested in boiler welding send for a reprint of "Welding of Boilers", published in The Welding Engineer of January.

HENDERSON WILLIS WELDING AND CUTTING COMPANY

11th and North Market Streets **St. Louis, Mo.**

Apex Walloon Welding Wire

"The Highest Quality Welding Wire Made"

Low Melting Point
Free from Lime or Slag
High Tensile Strength
Every Rod Perfectly Sound
ALWAYS Uniform

Not the lowest in price but the highest in quality

PRICES

3/32"—1/16"	24c	per lb.
1/8" —5/32"	19½c	per lb.
3/16" and larger	17½c	per lb.

Intermediate sizes next higher price

Complete Stock, All Sizes
and Lengths on Hand

Apex Steel Corporation

50 Church Street, New York City **Warehouse, Brooklyn, N. Y.**

W. E.

TRIAL OFFER

Apex Steel Corporation
50 Church Street, New York City

Please send us for SERVICE TEST your 8 lb. standard sample package of APEX WALLOON WELDING WIRE, for which we enclose $1.00.

Size..... Length.....

Name..... Address.....

We Can Save You Money

ON

GAS AND OXYGEN

USE

WELD Trade A Mark CAST FLUXES

"Weld-a-cast" is a scientific combination of chemicals, that causes the metal to melt rapidly, shortening the operation, thus economizing in time, gas and oxygen.

"Weld-a-cast" adheres readily to the hot welding rod which picks up just enough and none is wasted; it does not blow away but melts at once; it eliminates blow holes and leaves the metal soft.

Write For Free Samples

CORTLAND WELDING COMPOUND CO.
CORTLAND, N. Y.

Welding Pincers

Use up the short pieces of Welding Metal

This pincer enables the welder to use up his strips of metal almost to the end, all the time keeping his hand a good distance from the heat.

The handle is always cool, no matter how short is the piece of welding metal.

The time saved in welding the strips together quickly pays for the pincers.

Pressing the spring handle releases the jaws to pick up the metal. Length of pincers, 19 inches. Holds rods of 3-16-inch to ½-inch diameter.

Price $1.00

One sent to the address of any welding shop for 30 days' trial, on receipt of $1.00. If not satisfied money will be refunded on return of pincers.

Jobbers and Agents, write

C. SORENSEN

18 E. 16th St. CHICAGO

Aluminum and Cast Iron Flux

AN Aluminum break when melted does not flow together as other metals do, but the edges creep away from each other. There is a film on the surface, dull grey in color. This film is **ALUMINUM OXIDE.** It must be destroyed before your weld can be a success. By using **RED DIAMOND** Aluminum Welding Flux the aluminum oxide is instantly destroyed and the metal assumes a bright silvery appearance. By adding **RED DIAMOND** Flux with the hot welding rod, in the usual way, not only does the aluminum oxide disappear, but dirt and grease as well.

A trial can of **RED DIAMOND** Aluminum Welding Flux will convince you that this is the flux you have been waiting for. Put up in 2 pound cans, $3.00 per can.

The best insurance a welder can have that his welds will be sound and free from craters or blow holes is to use a good flux, made scientifically by chemists who understand the needs of the welder.

The object of a cast iron flux, or in fact any flux, is to eliminate the **OXIDE** and other impurities which form on the surface of the weld, caused by the heat and combination with oxygen of the air. The reactions are the same as in a blast furnace or cupola and flux is used to **CARRY OFF THE SLAG.**

BLACK DIAMOND Cast Iron Flux, when dropped on the molten surface of the weld, instantly clears the metal of iron oxide and other foreign substances, leaving a clear, mirror-like surface, which enables the metal to run together. This condition makes a sound weld.

A very small amount of **BLACK DIAMOND** Cast Iron Flux is required to assure a good weld. The price is a secondary consideration—it's the quality that counts. Put up in 2 pound cans, $1.00 per can.

Chicago Welding Compound Co.

Transportation Bldg. Chicago, Ill.

Our Service Department is at your service.
Consult us about your flux troubles.

Swift Oxygen

For Welding and Cutting

Unsurpassed for Quality

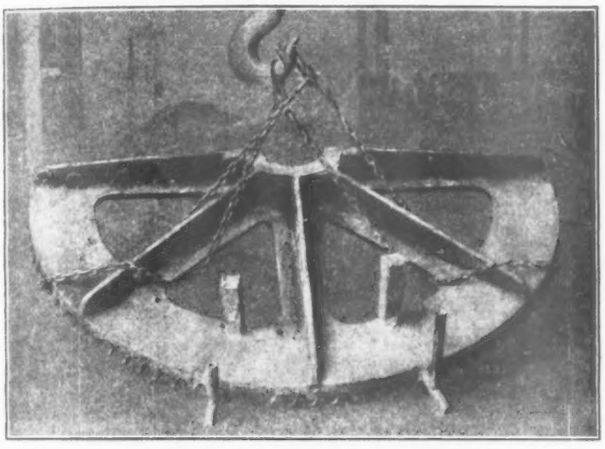
Pure Oxygen Electrolytically Made under the direct supervision of our Chemical Laboratory. It is carefully controlled by chemical analysis, thus insuring the highest obtainable purity.

We carry a large stock on hand—so can fill orders immediately

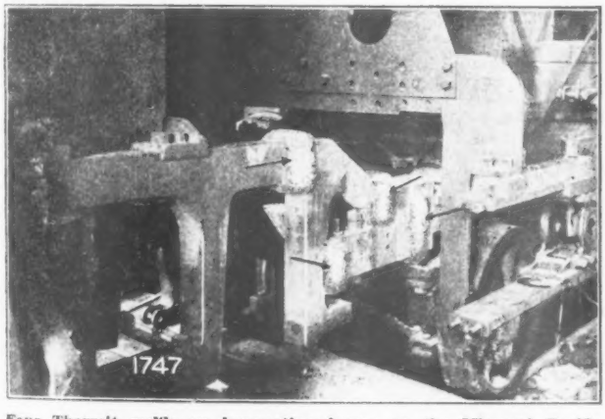
Swift & Company

Oxygen Department **Union Stock Yards, Chicago, Ill.**

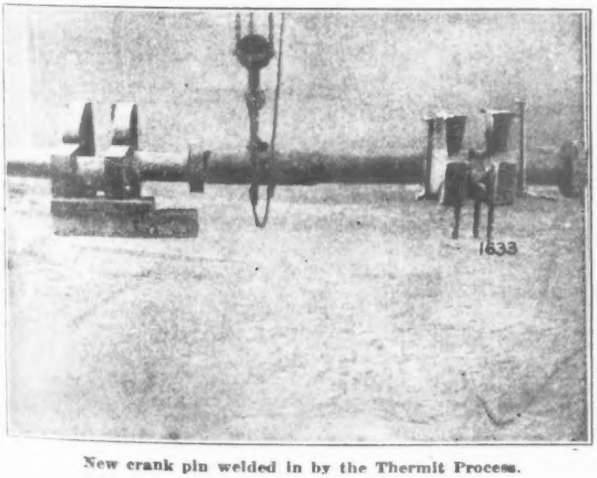
New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.



Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

THERMIT

The Only Reliable Process for Welding Heavy Sections

THIS Explains Why Railroads and Steel Mills Used Over One Million Pounds of Thermit in 1917. Also Why 95% of the Railroads in the United States and Canada Having Over 10 Locomotives, Use Thermit for Welding Frames and All Heavy Sections.

There are few machine parts which are subjected to greater strains or more severe shocks than a locomotive frame or a blooming mill pinion. Yet Thermit welds on such parts are being made every day and STAND UP IN SERVICE FOR YEARS. The reason for this is that, unlike ANY OTHER WELDING PROCESS, the steel to make a Thermit weld is produced IN BULK at a temperature of 5000° F. Furthermore, results are not dependent on the individual skill of the operator.

We have ample proof for all our claims and our long list of satisfied customers who come back week after week, month after month, and year after year for MORE THERMIT is a never ending testimonial to the efficiency of the Thermit Process.

Remember that Thermit should not be confused with either oxy-acetylene or electric welding. It stands in a class by itself. It welds sections which cannot be successfully welded by any other method.

Let us tell you more about it. Write for pamphlet No. 1779.

* * * *

Metal and Thermit Corporation

(Successors to Goldschmidt Detinning and Goldschmidt Thermit Co.)

The Equitable Building
120 Broadway, New York

7300 So. Chicago Ave., Chicago
329-333 Folsom St., San Francisco
1427 Western Ave., Pittsburgh
15 Emily St., W., Toronto, Ont.

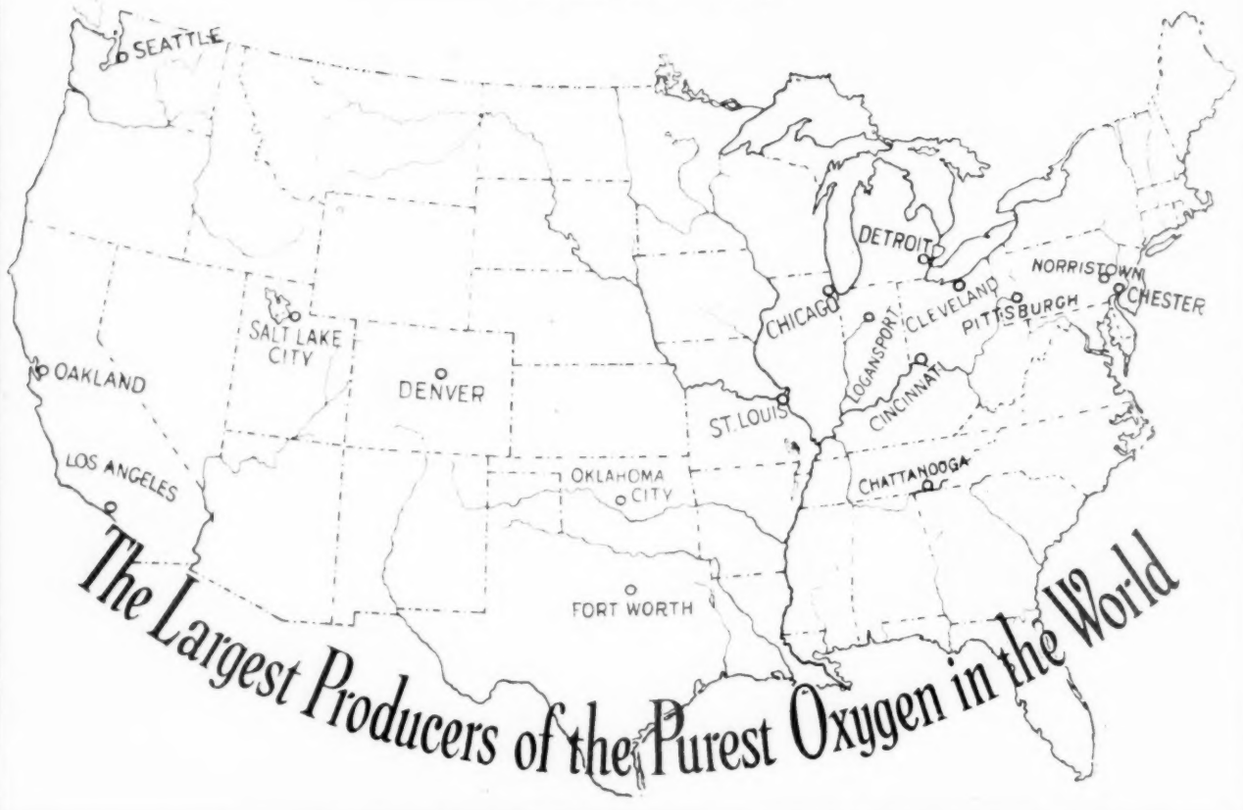
BURDETT OXYGEN COMPANY

AND ASSOCIATED COMPANIES

ELECTROLYTIC OXYGEN and HYDROGEN - 99 1/2 % Pure

Service from the following BURDETT PLANTS

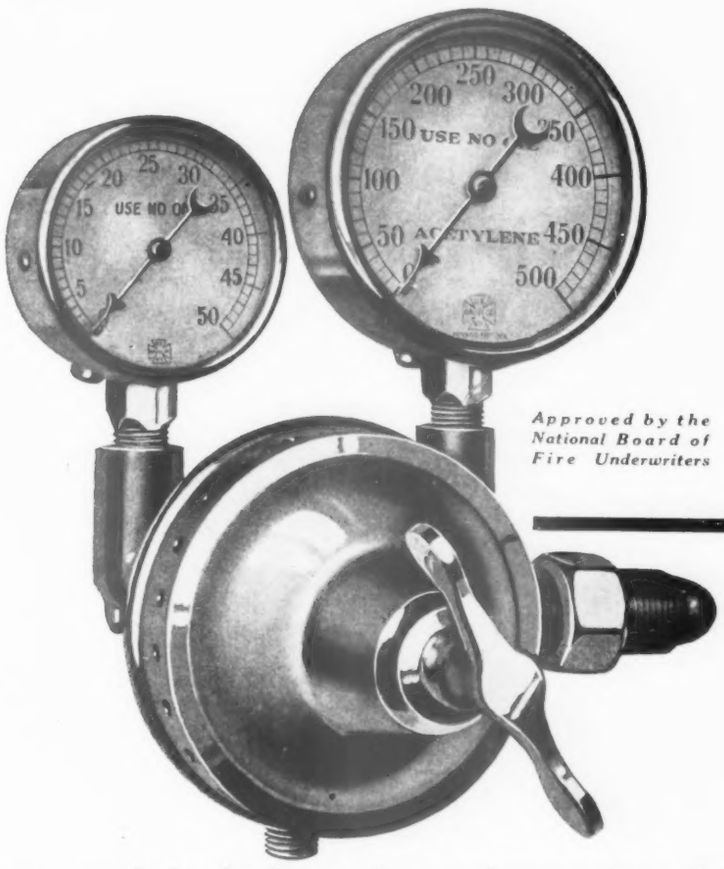
Seattle, Wash.
Los Angeles, Cal.
Oakland, California
Salt Lake City, Utah
Denver, Colorado
Oklahoma City, Oklahoma
Fort Worth, Texas
St. Louis, Mo.
Detroit, Michigan
Logansport, Ind.
Chattanooga, Tenn.
Cincinnati, Ohio
Pittsburgh, Pa.
Chester, Pa.
Norristown, Pa.
Cleveland, Ohio
Chicago, Illinois



The Largest Producers of the Purest Oxygen in the World

Welding and Cutting

Apparatus for Master Welders



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THE USE AND MISUSE OF OXY-ACETYLENE EQUIPMENT

By C. J. NYQUIST*

It is a fact that comparatively few accidents have, during the past ten years, happened to users of oxy-acetylene welding and cutting apparatus in this country. This, I know, appears to be a broad statement, but in comparison with many other industries, and by close observation of our own, I can come to no other conclusion. Newspapers have often reported explosions of gasoline stoves and brazing pots as due to acetylene, unscrupulous men have talked about explosions for want of real selling arguments, or for other reasons best known to themselves, resulting in an entirely unjust and exaggerated misunderstanding of the process. But what of exploding molasses tanks, the many and serious calamities caused by illuminating gas and by high-tension electric wires, the daily occurring automobile accidents, transmission victims, and the long list of risks in almost every mechanical and technical industry and occupation?

During the fourteen years I have devoted to the oxy-acetylene industry as a welder, instructor and manufacturer of apparatus, I have not personally seen one single oxy-acetylene welder or cutter seriously injured. While accidents have happened—and I have had occasion to investigate some of them—nearly all of those I know of have been caused by gross negligence, willful carelessness, just plain ignorance or conditions chargeable to impure gases and defective gas containers. Aside from the last two, over which the welder has but little control, it is evident to me that with reasonable judgment in the selection of apparatus, and fairly intelligent use of them the risk is no greater than with almost any other mechanical equipment, especially in view of the fact that the oxy-acetylene equipment is subject to so much misuse and careless handling. Any and all accidents are, of course, undesirable, and it is particularly from this point of view that I wish to point out to the users of oxy-acetylene welding and cutting apparatus how they should be properly handled, and to call attention to working conditions which may be more or less hazardous.

Among the equipment and materials used by the oxy-acetylene welder and cutter are the following: Oxygen and acetylene cylinders, oxygen and acetylene gas generators, gas purifying and drying devices, gas storage tanks, gas lines, gas manifolds and fittings, flash back preventers, oxygen and acetylene gas pressure regulators, welding and cutting torches, hose, connectors and adapters, goggles, spectacles, aprons, shields, preheating, chipping, and grinding equipments, cranes, chainfalls, rollers, the general line of hand tools for preparing and finishing the work, and, of course, the gases, charcoal, asbestos paper and welding materials.

Oxygen and Acetylene Cylinders.

The welder is so used to handling oxygen cylinders that he is quite apt to forget that they contain gas under an unusually high pressure. Ordinarily the cylinders are thrown about as if they were so many chunks of pig iron, are dumped off wagons, oftentimes top end first, stacked up on scrap and slag heaps, are oil and mud soaked or left unprotected in the open until covered with dirt and rust. The welder is not always to blame for this. The helpers, the store keepers, the freight house men, and first and last, but not least, the oxygen companies own drivers are largely at fault. I am not making any pleas for the gas companies; it is only for the best interest of the user of oxygen, that I state, that it is nothing short of criminal to misuse the cylinders. To throw oxygen cylinders off a wagon onto a hard pavement which may result in broken cylinder valves is to take a long and unnecessary chance. A boiler maker is wary of caulking a boiler under a pressure of 200 pounds, but the very same man thinks nothing of kicking an oxygen cylinder carrying a pressure of 1,800 pounds per square inch off a 10-foot scaffold.

"Use no oil" warnings are printed on the gas companies invoices and tags, the oxygen pressure regulators are marked in the same way, pressure cards and general instructions contain the same information, but in spite of all efforts to protect the user of the gas, welders lubricate oxygen cylinder valves with oil and the cylinders are often returned to the charging stations so greasy and oil soaked that the valves have to be removed in order to clean them and the cylinders before recharging with gas. Oil must be kept away from cylinder valves, as the presence of oil may result in bursting regulators. If any lubrication of the threads on the valves is needed, use soap water.

Reasonable care must be taken when attaching a pressure regulator to the cylinder valve. Unfortunately the threaded stems on the valves sometimes vary in diameter, resulting in that the regulator nut fits too tight or too loose. If the fit is too tight the result is often a frozen nut and if too loose cross threading. In either case the threads will be damaged and the cylinder valve spoiled. The regulator nut should go on fairly easy by hand up to within one or two threads so that no undue strain is put on the valve by the use of the wrench.

Both the valve stem seat and the corresponding regulator stem seat should be wiped clean. Sand and grit in any metallic seat results in unnecessary expense, leaks and losses. If a valve sticks hard or is too loose, leave it alone. To loosen packing or retaining nuts on filled gas cylinders may result in parts of the valve being blown off. It is also bad practice to use wrenches or hammers to force the hand wheel on the valve as the tap on the valve stem may easily be broken in that way.

Oxygen cylinder valves should be opened slowly. The sudden rush of oxygen under high pressure into the regulator is sure to damage it, especially if the spring pressure on the

*President, Torchweld Equipment Co.

diaphragm has not been released. The gas pressure regulators and the gauges attached to them are very sensitive instruments and must be kept in good order; the easiest way to ruin them is to overstrain them. Open the cylinder valve slowly.

What has been said about the care of oxygen cylinders also applies to acetylene cylinders, only more so. While lubricating oil in presence of acteylene is harmless, it is entirely unnecessary to use oil on the cylinder valves. Acetylene cylinders are filled with a porous substance, which makes it possible to charge them with acetylene under pressures which otherwise would be prohibitive. This porous substance must, however, be uniform and one of the best ways to maintain that condition is to handle the cylinders with care.

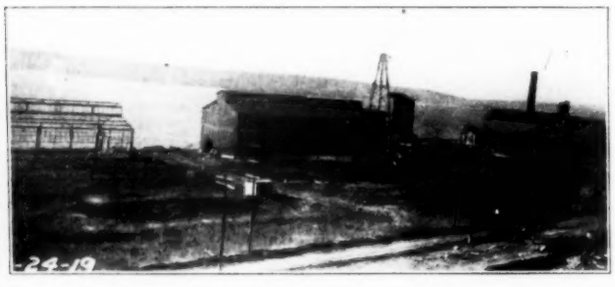
As the acetylene is inflammable it is self-evident that the cylinder valves must be closed absolutely tight when the cylinders are not in use. Any inflammable gas allowed to escape in sufficient quantities and in a confined space is dangerous, and acetylene is in this respect no exception.

Acetylene cylinders used for welding should be kept in upright position. Some means should be provided to prevent the gas cylinders from toppling over, which generally results in broken regulators and gauges. Leather straps or iron bands serve the purpose, but the best way is to use suitable hand trucks on which the cylinders are securely fastened by means of chains or straps.

NEW CARBIDE PLANT.

It is expected that the new calcium carbide plant of the Gas Tank Recharging Co., Keokuk, Iowa, will be on an operating basis in from 60 to 90 days.

The entire plant consists of five units, as follows: The main factory building 45 by 150 feet and 80 feet high, houses the electric furnaces, transformers, crushers, conveying machinery, etc. The can making plant is 36 by 80 feet will be used exclusively for the manufacture of calcium carbide containers or drums. The battery of eight bee hive Connellsville type coke ovens will be used exclusively for the production of coke, this together with a battery of two Stacey-Schmidt lime kilns, where lime will be burnt, will furnish the main plant with the raw materials, required for the pro-



duction of calcium carbide. A 500-foot span Lidgerwood cableway apparatus and towers is provided for the handling of the raw materials. These five units are all of fire proof construction.

When the units have all been fully installed and are in operation, it is expected this plant will produce approximately twenty to twenty-five tons of commercial carbide daily.

The illustration shows a late picture of the plant, from which it will be noted that the skeleton building on the extreme left is not completed yet. This was partly due to war conditions prevailing at the time this project was started.

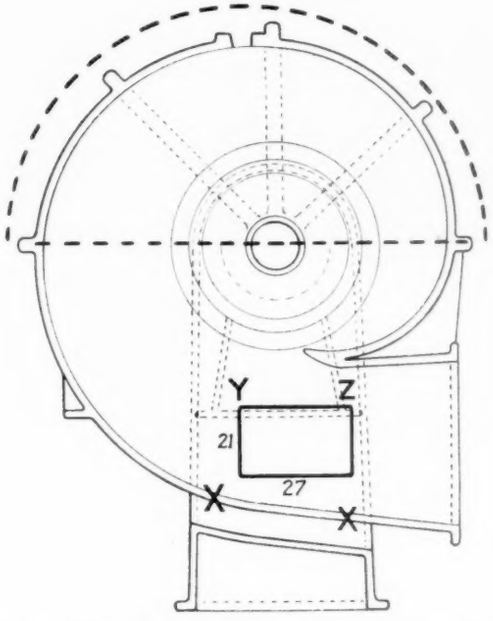
WELDING A BIG PUMP.

Editor: I am enclosing a blue print of a centrifugal pump that I welded a section of last summer. This section weighed 9,500 pounds.

I welded a patch into this section where the piece had thinned down to ⅛ inch in molding on account of defective core being too large. Owing to the large demand for these pumps for drainage purposes this was welded rather than wait for recast. This was for the United States Government.

The patch was 21 by 27 inches, molded in factory to size, by 1⅛ inches thick, beveled and held in place by four bolts with washers on top and bottom till tacked in place with torch.

This was preheated with charcoal in baskets and pans (from foundry) directly under the patch in the inlet of the pump and two Hauck torches which were played directly on the rim to take care of the expansion from X to X. This was brought up to red heat, allowing the radius or curvature to take care of the expansion in the opposite direction.



Welding commenced at Z thence to Y which was hot test at time of commencing. Then the same on opposite side of patch. Then bringing up the heat in the rim from X to X commenced at Y and welded toward the rim. Then at Z toward the other corner toward rim. During the time the two torches were played on the rim as indicated before.

After finishing, the larger part of the surface was covered with charcoal and the heat equalized as near as it could be with the torches.

We are aware that this is not an advisable manner to handle a large casting like this, but taking this chance we saved the time it would have taken to recast. Red lines on the blue print marked 21 by 27 inches show patch. Other red lines mark the part not assembled when the welding was done.

Welding time required 10 hours. You will also find enclosed a small blue print showing pump assembled.—D. J. Dukes.

Mr. Alden R. Ludlow, former vice-president of the Liquid Carbonic Co., of Chicago, Ill., assumed his new duties as second vice-president and sales manager of the Air Reduction Co., Inc., January 1, 1919.

Fig. 2. Students at Packard Plant, Detroit.

The first trade mentioned in the list of occupations mailed every male in the United States as a part of his questionnaire was that of "acetylene welder."

It was the privilege of welders to have the fabricating of a real war-winning factor as a part of their work. The Liberty Motor is essentially a product of the dexterity and skill of the welder.

Until the United States declared itself a participant in the great struggle, manufacturers looked with askance on all forms of welding. It seemed to be a motto oft repeated "Never weld when you can do anything else, it is too uncertain."

When, however, this country, recognized as the greatest farthest advanced in the world for quantity production of machine tools and fabricated parts, was asked to get busy on a power plant that would pull the allied air fleets to victory, the welder was called into consultation.

Probably the real reason why the Liberty motor was an all steel, welded-seam proposition, was that the designing engineers who picked out the cylinders with the greatest horsepower for their weight chose the design of the German made Mercedes as their ideal in that respect.

Now we had been told that although a Frenchman, named Foureche, might have been the inventior of the oxy-acetylene welding process, which fact however was denied by the Germans in toto, they, the Germans, had done all the improving there was to be done on that process just as they had done to all other processes, even that of making war.

Knowing the attitude of the German welding trade to our infant welding industries, their supercilious condescension in admitting us into part of their so-called welding secrets, processes and metal formulas for a certain, very certain, price, we can imagine their contempt for all our careless, slipshod ways.

To start the Liberty engine to the welding room, we had in this country some plans drawn up by a picked board of engineers, a sample of a Mercedes motor, brought out of Germany at the last moment by one of the most distinguished of those engineers and our Yankee will to win.

The story of how in a few months we started to build the Liberty motor, how, in a few weeks welding shops were built, equipped and manned or rather feminined by trained workers is a story by itself. The story of one plan, the one where the motor was planned, first built and which attained highest quantity production during the war is an epic of American achievement, because in a few months we distanced the utmost efforts of years of preparation by an efficient and highly trainned nation of workers and planners in their own field.

On June 1, 1918, in the regular school rooms of the Packard Motor Car Company of Detroit, Mich., a welding class was formed. There were men and women from the factory and the farm, all of them ignorant of even the first principles of welding, but all eager to learn and imbued with enthusiasm. The school lasted for six months, until the armistice and in that time the welding department was furnished on requisition with 132 welding operators eighty-one of them women and fifty-one men.

Of course there were those who lacked the manual dexterity and the trick of application necessary to a sheet steel welder. There were thirty-two apparatuses in the school, the average time of instruction was three weeks and the percentage of those graduating into shop work should have been gratifying to those in charge of the school when furthere account is taken of the fact that the best instructors were badly needed on the welding floors.

A general review of the routine of the school work in the welding department shows the simplicity of the method used, the continuity of the course and the extent of the general knowledge obtained by the student.

The students are first taught the difference between oxygen

and acetylene tanks, stress being put upon the danger resulting from the use of anything containing carbon being brought in contact with oxygen.

They are warned never to use oil or grease on any fitting used in making up any apparatus for the use of oxygen. They are also told of the dangers attending any and all efforts made to transfer acetylene from one tank to another and are thoroughly schooled in the proper method of handling and using the regulators used in welding and cutting. This is for the purpose of eliminating the possibility of accident by spontaneous combustion in the regulators due to filling the oxygen regulators with acetylene gas which can be done by forcing the same through the hose into the oxygen regulators when the oxygen tank valve is closed and the regulators open.

They are shown that if the regulators are closed and the tank valve opened the acetylene in the regulators and gauges would be compressed sufficiently to cause spontaneous combustion and an explosion.

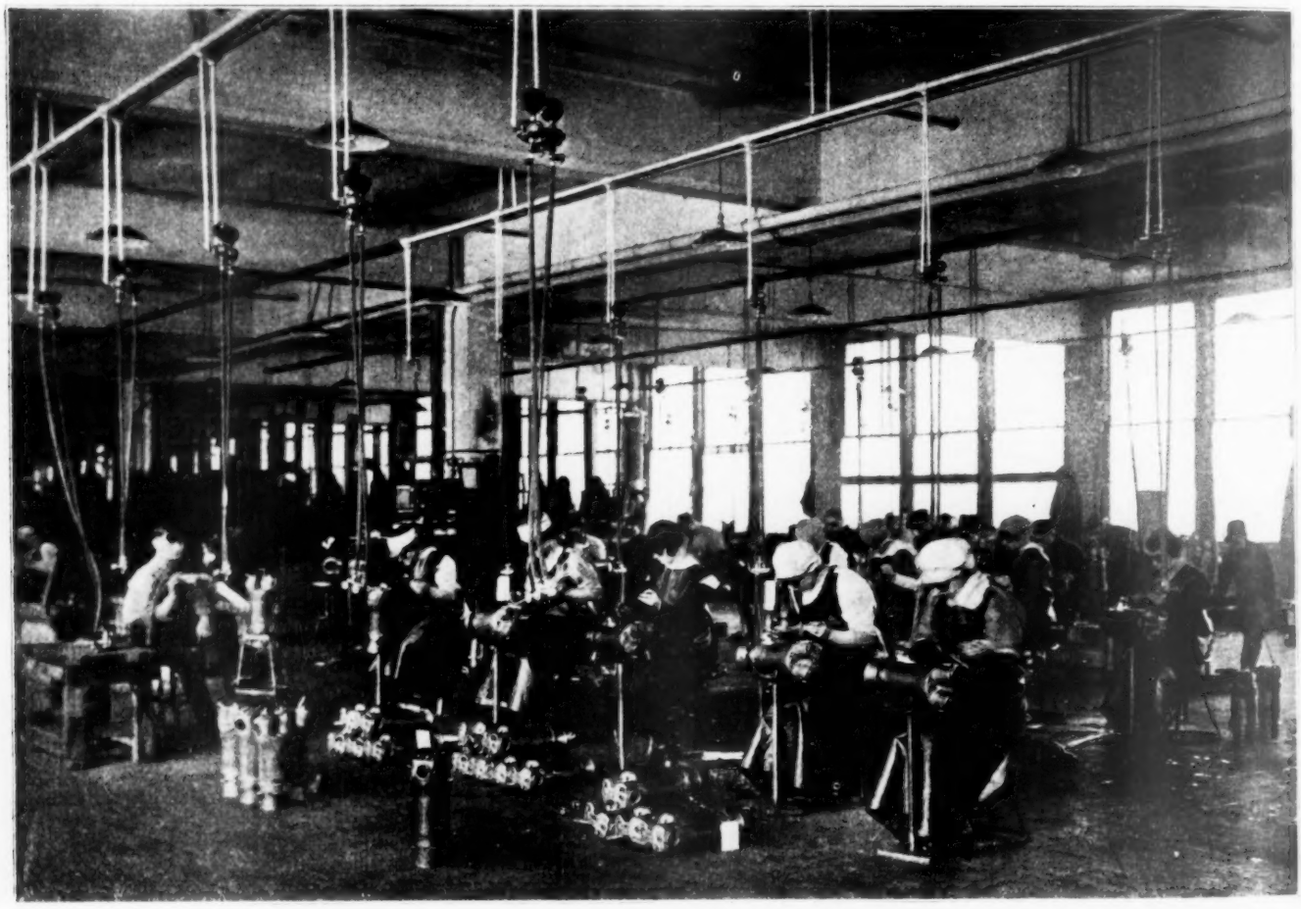


Fig. 4. Welding the Sheet Metal Water Jackets of the Liberty Motor Cylinders in Quantity Production—Packard Plant, Detroit.

The next thing taught is how to light and adjust the torch so as to obtain a neutral welding flame and that either the carbonizing flame caused by the use of too much acetylene or the oxidizing flame caused by an excess of oxygen in mixing will produce faults in the welds.

The student then melts the surface of a piece of sheet metal in parallel lines so that the lines show through on the under side to familiarize them with the heat necessary to weld through a section of sheet metal without burning. Several hours of this sort of practice produces great results.

Next the straight bead across the surface is taken up in order to familiarize the operator with the rate of melting of the welding wire. At this point the student is left to his own devices for several hours at a stretch to put in practice the theory absorbed from the verbal instruction, occasionally corrected as to technique of holding the torch and applying the filler rod, and reviewed on the effects of a surplus of either gas or oxygen and the effect on the weld.

From beads the student progresses to seams, where steady practice with occasional correction and supervision produces the best results.

Here the student is taught the necessity of the correct size of flame and welding wire as well as quantity of gas and oxygen used also the necessity of the metal in the weld being in a flowing state when the filler rod is added.

By holding the torch so that the force of the flame blows the metal back, the student is shown the condition of the metal immediately under the welding flame.

The student is taught to hold the torch steady, the only progress being along the seam, in order to confine the spreading heat to the smallest possible area around the seam to prevent expansion and contraction and consequent leaks and cracks.

Where wider surfaces than seams are to be welded a counter clockwise movement with the flame cutting square across the weld is used to make it easier to flow the metal added at the tip of the cone.

The timing of the heat of the weld at the point where the weld breaks through the under surface of the metal is practiced until an even breakage of the under side is obtained.

The examinations of the school are remarkable for their practicability and show the emphasis placed on actual practice.

QUESTIONS AND ANSWERS.

The following questions should be answered as briefly and at the same time as carefully as possible.

Ques. 1.—What are the requirements of a good oxy-acetylene welder, physically and mentally?

Ans. 1.—Good eyesight and steady nerves are very necessary. Muscular control is generally acquired but is none the less necessary.

The welder should be of a mechanical turn of mind and capable of considerable initiative, due to the fact that the work is of so entirely different characters.

Ques. 2-A.—What is the function of acetylene gas?

Ques. 2-B.—What is the function of oxygen?

Ans. 2-A.—Acetylene furnishes the carbon necessary to produce fire.

Ans. 2-B.—Oxygen furnishes the actual support for the flame and develops the heat contained in acetylene.

Ques. 3-A.—How is acetylene gas made?

Ques. 3-B.—How is oxygen gas made?

Ans. 3-A.—No. 3 acetylene is produced by bringing commercial carbide and water together.

Ans. 3-B.—Oxygen is produced by bringing air to its liquid state and boiling it, thereby causing nitrogen to separate from the oxygen and rising in the separator. The oxygen is then forced out of the separator by the pressure of the vaporized nitrogen, which is disposed of through the top of the separator. Oxygen is also produced by the electrolytic process of reducing water to its component parts which are hydrogen and

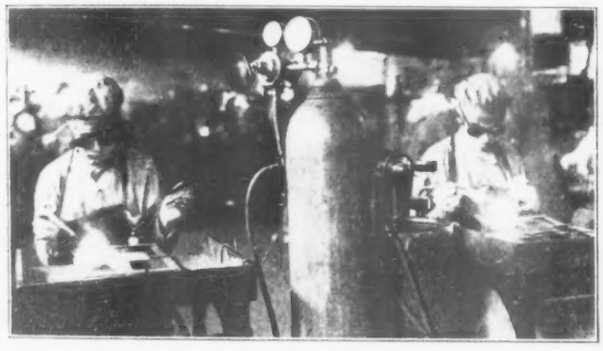


Fig. 3. Beginners Working on Sheet Steel for Penetration.

oxygen, the oxygen being drawn off from one pole and the hydrogen from the other pole of an electric cell.

Ques. 4.—What are the effects on the metal in the weld of an excess of acetylene or oxygen in the flame?

Ans. 4.—Too much acetylene will carbonize the metal and too much oxygen will oxidize the metal.

Ques. 5.—What flame should always be used in welding steel, cast iron, brass or aluminum?

Ans. 5.—A mild neutral flame.

Ques. 6.—Why the difference in the welding flame on steel and aluminum?

Ans. 6.—No difference in the quality of the flame and develops the heat contained in acetylene.

Ques. 7.—Is there an essential difference between steel and cast iron welding; if so what is it?

Ans. 7.—Yes there is. Steel is welded without flux and cools so rapidly that it is possible to weld steel in most any position, even over head if necessary. In welding steel the tip of the cone is brought in contact with the steel, cast iron on the other hand requires flux and owing to the fact that it cools slowly it cannot be welded in a position that will allow it to run from the weld; in this case the tip is not allowed to come in contact with the metal.

Ques. 8.—What metal, in your opinion, is the most difficult to weld, and your reason for such a belief?

Ans. 8.—Any of the bronzes, due to the fact that bronze melts at a lower temperature than other metals, also not being a base metal some of the ingredients have a much lower melting point than the others and are apt to burn before the other metals are melted.

Ques. 9.—What would result if oil or other carboniferous substance were to be present inside of the system when oxygen was admitted?

Ans. 9.—Spontaneous combustion would occur and a violent explosion would result.

Ques. 10.—Describe fully the line of action you would follow in attaching both regulators to the tanks and starting to weld.

Ans. 10.—The regulators should be examined carefully to ascertain if any oil or other carboniferous materials adhered to the fitting of tank connection. The regulator valve should then be backed up so as to allow the regulator valves to close, the hose valve should then be open and regulators attached to tank. Tank valves should be opened slowly and hose valve

Fig. 1. She Helped Win the War by Welding Liberty Motors.

closed to discover if any leaks are present in the regulator valve, this applies to both acetylene and oxygen. If regulators are O. K., acetylene is set to the required pressure and lighted at the torch, oxygen is then added and regulated to produce neutral flame.

Ques. 11.—How could an operator cause an explosion in either gauge when changing either tank?

Ans. 11.—By leaving both valves on a torch open, and not backing up the gauge valve in regulator being changed, and not shutting off the tank, thereby forcing the gas into the gauge being changed, the regulator is then attached to the tank and the oxygen or acetylene admitted. The oxygen or gas would be compressed in the gauge and an explosion would occur.

Welding AND

REGO TORCHES MAKE BETTER WELDS

FOR ONE REASON

Because the new principle on which REGO welding torches are founded insures a steel weld free from oxides.

As the gases come to the mixing chamber of a REGO welder they are so perfectly balanced that it is impossible for any excess of oxygen to escape and unite with the molten metal. There can be no excess oxygen in the flame from a REGO welder and therefore REGO welders make better welds.

FOR ANOTHER REASON

Because REGO welders flow the metal but never blow it. The oxygen is used at a low pressure and produces a soft flame.

AND STILL ANOTHER REASON

Because you can't backfire a REGO Welder.

Every time a torch backfires while one is making a steel weld the molten metal absorbs carbon or soot which is emitted from the tip and the weld is weakened. You can't backfire a REGO welder; therefore, REGO welders make better welds.

REGO welders insure better welding, more economical welding and more satisfactory welding, not only to the operator but to the owner and the user of the welded article.

REGO welders save gas, save time, save money. We guarantee they do!

REGO apparatus is sold with the distinct understanding that it must do exactly what we say. If it does not, (and you are the judge) you may send it back and get your money.

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REGO

Ques. 12.—What is the best method of welding malleable iron and describe it?

Ans. 12.—Malleable iron is seldom welded, but is braised, tobin or bronze being used as a filler, the work not being flowed.

Ques. 13.—How is it possible to cut steel with oxy-acetylene apparatus?

Ans. 13.—By bringing the metal to a red heat and then apply a jet of pure oxygen to the heated part.

Ques. 14.—What difference is there between a welding torch and a cutting torch?

Ans. 14.—A welding torch is built to handle a flame with only one orifice through which the acetylene and oxygen come already mixed, the cutting torch on the other hand has three or more orifices, one of which delivers pure oxygen, the others provide a neutral flame for the pre-heating flame.

Ques. 15.—What difference is there between a low pressure torch and a medium pressure torch?

Ans. 15.—The low pressure torch is built on the injector principle, in which the velocity of the oxygen draws the acetylene through the torch from a low pressure line. Moderate pressure torch is a torch built to handle the gas and oxygen under positive pressure.

Ques. 16.—Under what circumstances is acetylene gas very dangerous and how is this condition overcome?

Ans. 16.—Acetylene gas is very dangerous when put under pressure and the only solution discovered up to date for overcoming this condition is to store it in a tank packed with fiberous material and a solution of acetone to the amount not to exceed 40 per cent of the total capacity of the tank.

Ques. 17.—If carbide in bulk were to ignite or in some manner take fire, how could you extinguish it or bring it under control?

Ans. 17.—Smother it with sand or some other like substance, thereby depriving it of the air, consequently the oxygen necessary to sustain the flame.

Ques. 18.—What would cause a back fire in a torch and what are apt to be the results and how may this condition be overcome?

Ans. 18.—Overheating the tip, dirt in the orifice of the tip or trying to weld with exceedingly low acetylene pressure will cause back fire; multiple screening in the body of the torch or packing the same with ground aluminum will prevent the back fire from going into the gauge regulators.

Ques. 19.—What method is used to keep a back fire from entering the generator and an explosion resulting? You can either sketch or describe this.

Ans. 19.—Water traps are present in the line which would make it necessary for the burning gas to force its way down through two or more feet of water in several containers before getting into the generators.

Ques. 20.—What, in your opinion, is the most necessary knowledge to fit a welder to handle all kinds of welding successfully?

Ans. 20.—A *welder* to be successful should have an accurate knowledge of the expansion and contraction of all metals.

FRENCH WELDERS' CHILDREN'S CHRISTMAS FUND.

Our American colleagues have just given us the most delicate and most generous surprise, by taking up a subscription among themselves with the purpose of offering a Christmas fête to the children of the French welders, in order to give them a little joy and happiness at the moment when all the allied nations vibrate in unison in victory.

The statement of the motives for this subscription shows the delicacy and the friendship of the Americans, which we already knew. It contains also many praises for the French and invites all the members of the American industry of acetylene and autogenous welding to subscribe without delay in order that this fête may soon take place. However, by reason of the present delay in postal communications, we are advised of the results of this subscription too late to be able to arrange for the fête on New Year's Day. So, the distribution of American funds will take place some time in January.

For the present, then, we shall be pleased to send to our dear friends of America the thanks of our industries for this unforgetable act, and we can assure them that the generous gift which they are going to send us will bring happiness and will serve to show that, if there was mutual esteem before the war, this esteem has been transformed into affection which will be the basis of a closer and more intimate relation between them and us.

Pierre Rosemberg.

ORGANIZING.

Editor: We started organizing here last August and at the present writing have this point 100 per cent organized. We have made our demands for a charter to the American Federation of Labor.

We understand, through unreliable sources, that the American Federation of Labor have granted the welding to the boiler makers. If this is true we cannot understand how they did it. I believe this refers to ship yards alone, nevertheless, we are going to fight for our rights and must win in the near future.

Welding has grown in the past too much and is still going farther to allow any one or two or more crafts to control it. What would a man do that belongs to one craft, finding out that his card was no good in another place because his craft did not control that point?

Our aims are to get a charter of our own, independent of all other crafts, but affiliated with them through the American Federation of Labor, state federations and labor councils.

Now is the time for gas and electric welders, cutters, generator attendants and helpers, also head burners to join with us in our demands. It will be highly appreciated if the brothers would get together and sign their names to a petition that the American Federation of Labor grant us a charter. If the steps we have already taken do not get us this charter, then we can use your petitions. Let us hear from one and all and build our organization at once.

I hope to receive the signatures of every fellow workman in the United States.—H. A. Alber, chairman of Charter Committee, 221 Twenty-ninth Street, Newport News, Va.

Mr. Edward A. Miller has been appointed as assistant superintendent of the Jersey City plant of the Metal & Thermit Corporation, New York, N. Y. Mr. Miller was one of the pioneers in autogenous welding and cutting, having established the first oxy-acetylene shop in New York City early in 1908 under the corporate form of the Acetylene Welding Co. In addition, Mr. Miller has had long and varied experience in pattern shop, foundry, machine shop, blacksmith shop and boiler shop practice, and in manufacturing and marine work, some of his former connections being the Essex Foundry, Newark, N. J.; Pioneer Iron Works, Brooklyn, N. Y.; Standard Aniline Products, Inc., Wappingers Falls, N. Y., and the National Conduit & Cable Co., Inc., Hastings-on-Hudson, N. Y. Among Mr. Millers' notable jobs were the removal of the abandoned sheet steel piling encountered under the pneumatic foundations of Dry Dock No. 4 in the Brookilyn Navy Yard, in 1910 and 1911, and the demolition of the ruins of the old Equitable Building in 1912.

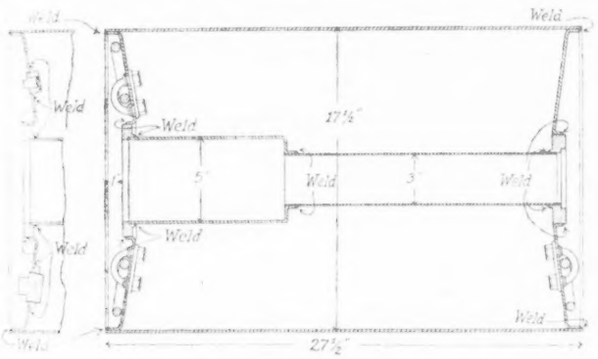
WELDING DEPTH MINE BODIES

By P. F. WILLIS*

The welding of depth mine bodies, which encased the destructive mechanism so feared by German submarines, engaged our attention for some eighteen months.

The welding of these bodies have presented no serious problem, with one exception. Great care had to be exercised in the work in view of the fact that on one operation an allowance of only .005 of an inch was permissible; on another operation only 1/16 of an inch. Both the British and American mines were built along the same general plan, differing however somewhat in detail. As the British mine was the first one which we made and as it was more difficult to manufacture than the American, we will describe it first.

It will be noted from the illustration that viewed externally it might be very well likened in appearance to an "ash can," the name facetiously given it by the Marines. The length was 27½ inches and the diameter 17½ inches and the ends and sides were made from ⅛-inch galvanized sheets. The body sheet was rolled and the longitudinal



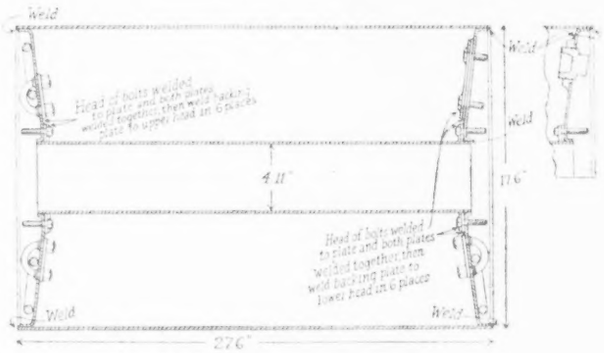
British Depth Mine.

seam welded, the sheet being held in a clamp or stake during this latter operation. The ends were dished and in addition they had their edges flanged and these ends were set in the mine body and the flanged edge of the end and the edge of the cylinder body welded by simply melting these two edges together, no filler wire being used. In the top end a filler bushing and also an air hole bushing were welded in. The pistol or firing mechanism operated in the tube or cylinder which was located in the center of the tank extending the full length and being welded at each end to the top and bottom of the depth mine. The welding and location of this cylinder was the one difficult part about the mine. This cylinder was 5 inches in diameter at one end and 3 inches in diameter at the other. The 5-inch portion was a drawn body of ⅛-inch stock while the 3-inch portion was a flame welded tube of ⅛-inch metal. In welding this 5-inch tube to the 3-inch tube we experienced a great deal of trouble with the 3-inch tube warping out of alignment even when held on a jig only .002 of an inch less diameter than the tube itself, in some cases it being almost impossible to drive the welded tube off the jig. We finally overcame this trouble altogether by using two men to weld, one being positioned just opposite to the other. This inner tube was tested with a jig which was .005 undersize and the jig had to drop into the tube its entire length and permit of pulling it out without lifting the tube off the floor.

A heavy steel flange was welded onto each end of this tube and it was then inserted in the mine body proper and these flanges welded to the top and bottom. The space between the inner tube and the outer wall of the mine was filled with T. N. T. and as stated above, the inner tube held the pistol or firing mechanism which was operated by the pressure of the water. Before launching the mine could be set to explode at a depth of 50, 100, 150 or 200 feet, as desired.

The American mine was much more simpler in construction and easily manufactured. In general appearance and, dimensions they were practically the same, but the inner or pistol tube was one straight piece. The illustration shows the general design of this with notation were welds were made and the manner of making them. All mines were tested under 25 pounds air pressure for leakage. As the metal was all galvanized, the zinc fumes at times was very objectionable to operators even though a 72-inch exhaust fan was used to draw the fumes away.

Flame welders generally should feel proud of the fact that


Weld
Weld
Weld
Head of bolts welded to plate and both plates welded together, then weld backing plate to inner head in 6 places
4.11"
11.6"
Head of bolts welded to plate and both plates welded together, then weld backing plate to inner head in 6 places
Weld
Weld
27.6"

American Depth Mine.

the oxy-acetylene torch made it possible for us to deal with the submarine menace. While the number of welders employed on this work varied, we average about sixty operators and about 200 mines per day.

Mr. Arthur F. Braid has been appointed sales manager of the Metal and Alloy Department of the Metal & Thermit Corporation.

Mr. Braid came to the company seven years ago as a traveling salesman, but after a few years of most successful service in this capacity he was appointed assistant superintendent of the Jersey City plant, in charge of the manufacture of carbon free metals and alloys. When the United States entered the war, he assumed active charge of the metal sales at the New York office of the company.

Mr. Braid is widely known throughout the trade and is a member of the American Iron and Steel Institute, the British Institute of Metals and many other societies and scientific organizations. His friends and associates wish him every success in his new position.

The Mechanical Engineer of the N. Y. N. H. & H Railroad, in a paper read before the New England Railroad Club, warned members that Welding is not a trade that can be "picked up" in a few days. He advocates proper training for welders.

*President, the Henderson-Willis Welding & Cutting Co., St Louis, Mo.

WELDING A CYLINDER OF A 300-TON CAPACITY HYDRAULIC PRESS.

By Nels Johnson.

I have no equipment with which to take pictures myself, hence I cannot take pictures of interesting welding jobs without going to a lot of bother and the expense of having someone else do it.

I shall at this time make a sketch of the job referred to, and I hope I will make it clear enough to form from it an opinion of the size of the weld, at least.

The casting, a cylinder of a hydraulic press, broken in two pieces, was a heavy one; estimated weight about three and one-half or perhaps four tons. It is the biggest welding job handled in the shop and by far the biggest weld I ever made. The job was done at the Soo Line Railroad shops, Minneapolis, Minn.

The cylinder has now been in continuous service over two months since it was welded. I think it is now safe to call the job a complete success, and being somewhat out of the ordinary, worth while to be mentioned in *The Welding Engineer*.

Fig. 1 shows a sketch of the cylinder as it appeared lying on the floor, the break being Vd out, and both pieces put together ready to be set up for welding. The V was cut out on a planer and all low and uneven places finished by

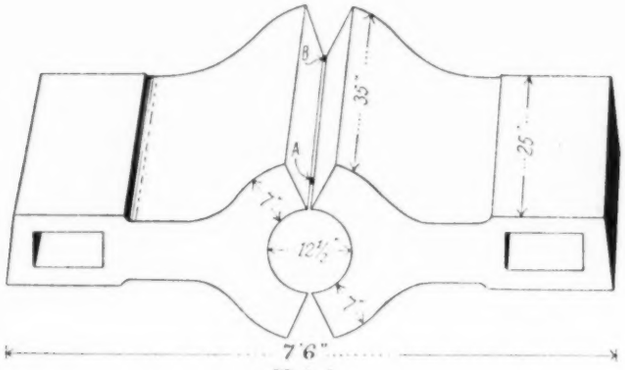


Fig. 1

chisel and chipping gun, the V being cut deep enough to make an opening about ⅛ to 3/16 inch at bottom as shown in the sketch.

In order to put the two parts together as nearly right as possible, I left four small places opposite each other that I did not chip quite through at bottom of V. See Fig. 1, A and B. By the aid of these four places I had no difficulty to get the cylinder back to right shape when it was set up for welding.

After the casting was thus prepared a solid foundation was built of fire brick, four short pieces of steel rails put on top and made level, and the two pieces put in place in upright position on the steel rails. There was left space enough from the floor to make room for a good fire.

A brick furnace was then built around the whole casting. An opening was left on both sides to expose the whole V and allow welding to be done. See Fig. 2.

Carbon blocks to put under the bottom were prepared for both sides, and temporary brick walls built in front of the openings. The top of the furnace was covered with sheets of heavy asbestos.

Instead of using carbon blocks to hold the metal in front of the weld, I had in the meantime prepared pieces of ¾ square iron, bent a little more than the radius of the casting, and long enough to extend beyond the width of the V on both sides about ½ inch.

Heating was done during the night and when the welders appeared on the scene in the morning the whole casting had a bright red heat.

The temporary brick walls were then taken down, the top of the opening covered with sheets of asbestos, the carbon blocks for the bottom put in place, and welding started on both sides at the same time. The casting was kept at the same heat during the whole process of welding.

The job being a big one, and quite warm too for that matter, four welders were put on the job, changing about every twenty minutes. Thus both sides were welded from the bottom up at the same time. As the welding progressed the crescent shaped ¾ square pieces of iron were put one on top of the other until the top was reached. The V at the top was 26½ inches long and 7½ inches deep; 550 pounds of ⅜ cast iron welding rods was used to make the weld.

The job was finished in a reasonable length of time; that is, satisfactory to all concerned. I do not care to go more into detail about welding time, gases and preheating fuel used, etc., for the reason that I do not believe in setting records, not even for myself to go by.

On a big responsible job where the cost of the welding and other work connected with it will run into hundreds of dollars, results should under all circumstances be the first aim. It is well not to take any chances; a couple of hours more or less does not matter a great deal.

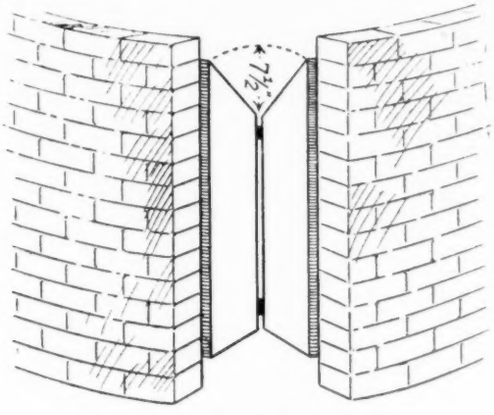


Fig. 2

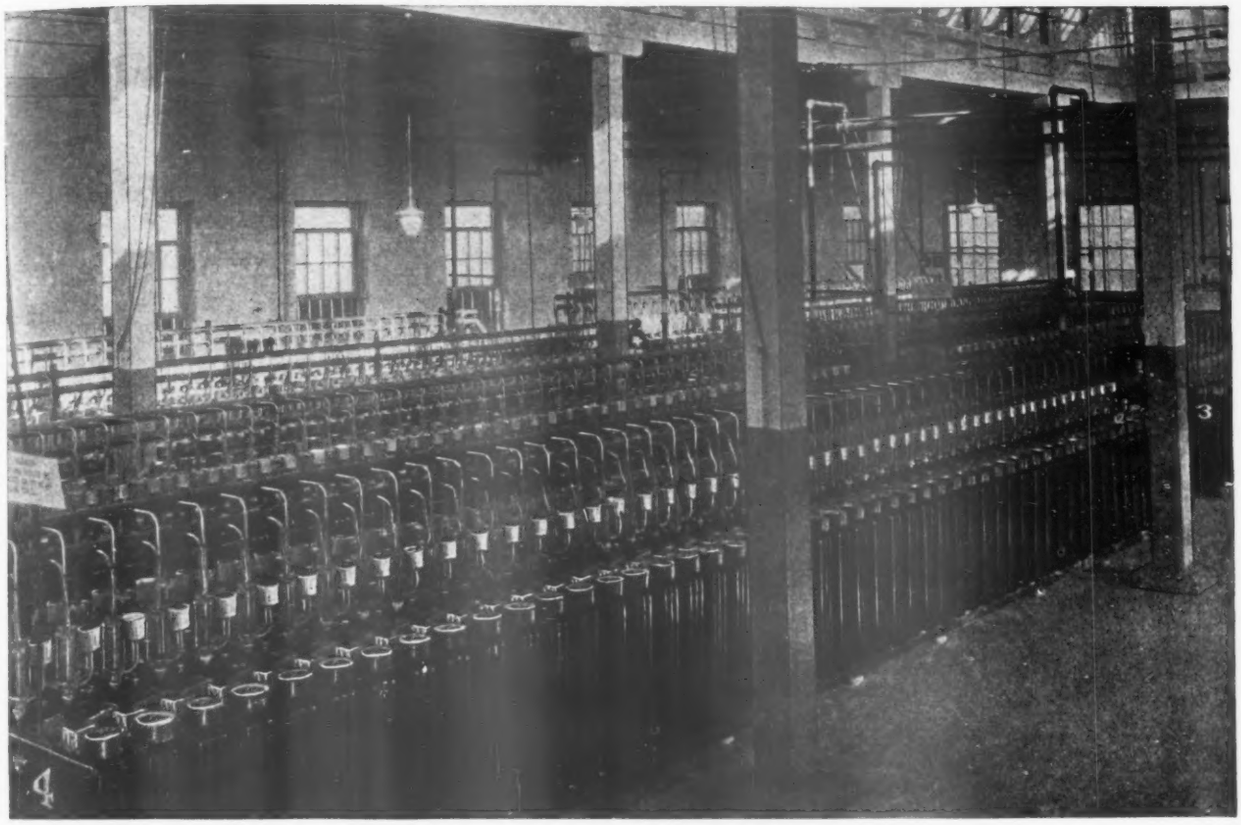
I have read articles where the writer stated exactly to the minute how long it took to do the job. Well and good, it is all right providing it is not exaggerated.

But I have found in my experience that on a certain job where everything goes a sailing, a similar job will sometimes require more time. Unlooked for and unavoidable obstacles will sometimes cause a delay. Therefore, I will not mention speed. I prefer to leave that to someone else.

After the casting was cool the ¾ square pieces of iron were knocked off and the cylinder rebored. It was found that the cylinder was less than 1/16 inch out of bound.

I am writing this article to help advertise our trade, and to help to bring out the fact that an oxy-acetylene weld will hold even where great strength is required. Too many are still of the opinion that it is fit only to fill up holes and worn spots.

Let us do a little advertising in order that we may broaden the field of the welding industry. Very few of the thousands of welders throughout the country ever write in the welding magazines. It ought not to be so. If you have done a big job. **Write about it.**



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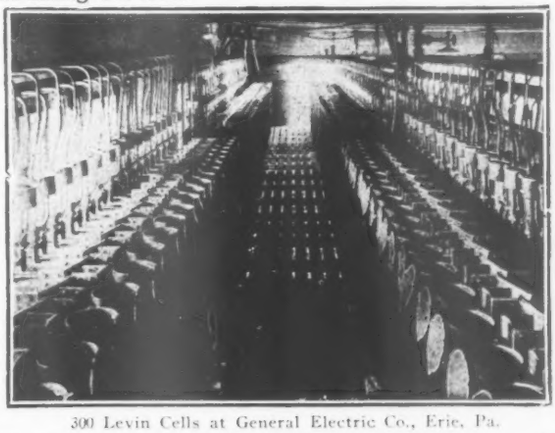

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PIPE WELDING

By B. K. Smith

The ever-increasing importance of the welding trade as a factor in modern industrial life calls for a system of extension especially adapted to present-day conditions. The opportunities in railroad, machine, automobile, constructing, foundry, blacksmith and commercial welding shops are almost unlimited. Stripped of technicalities welding is the theory and practice of reclamation and saving. It is evident, therefore, that the oxy-acetylene, electric and thermit welding processes concern all mechanical institutions, because, these welding processes govern and control a certain amount of production and because these processes lower depreciation of equipment by increasing the life of machinery.

There are still some branches of our mechanical industries where welding is not understood. One of them is the plumbing and pipe-fitter's shop. There is no question as to the practicability of the use of the welding torch in these shops for welding pipe seams and pipe connections, and there is no doubt that the American plumbers and pipe fitters will avail themselves of the use of the welding torch and not only save time and money but also increase their efficiency.

Welding Pipes for the Locomotive

One of the greatest fields for pipe welding is the locomotive. Among railroad men it is a well known fact that many of the failures experienced on the road are due to pipes leaking or breaking, due chiefly to threaded joints. About eight years ago the writer succeeded in eliminating two-thirds of the pipe fittings and replaced them with welded joints on passenger locomotive No. 3325, at a Pennsylvania railroad shop. After six months' service we obtained the following results: 80 per cent decrease in pipe failures and 75 per cent decrease in cost of maintenance. The only criticism voiced among railroad men at that time was that in case a welded pipe should ever break or burst on the road, where a welding torch could not be obtained, the locomotive would be out of service until the arrival of a welder from the main shop. The writer's advice in this case was to establish a welding unit and an operator at different outlying shops, but this seemed at that time an impossibility and the idea of welding pipes was dropped.

Parallel with this operation is the welding of flues to the boiler sheet, which is considered practical by 40 per cent of our railways, yet in case of a welded flue failure the locomotive is sent back to the main shop to re-weld the defect, and this operation is considered practical.

Before I describe the difference between a threaded joint and

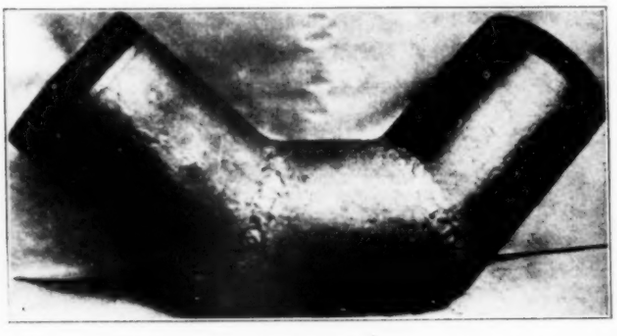

Fig. 1. Welded Pipe.

a welded one, let us review the most important organ that needs the most piping—the air brake. The automatic parts of the air brake, consisting of an air pump that produces the pressure, the pump governor that controls the pressure, the main reservoirs where the pressure is stored, the driver brake valve which controls the admission to and exhaust of air from the brake pipe, to release and apply the brakes, have all gone through many changes since their discovery in 1874, until now when the automatic air brake, the automatic quick action brake, the high speed brake, the independent straight air brake and the train air and signal, have reached a high efficiency; the brake pipes, however, that are the connecting bowels of this organ, have not made the same progress; *they are still used in their crude form, as when they were first applied.* The air brake piping of the locomotive, the least developed member of the air brake, can thus be pitched to the same high efficiency as the other members, reducing the multitude of nipples, tees

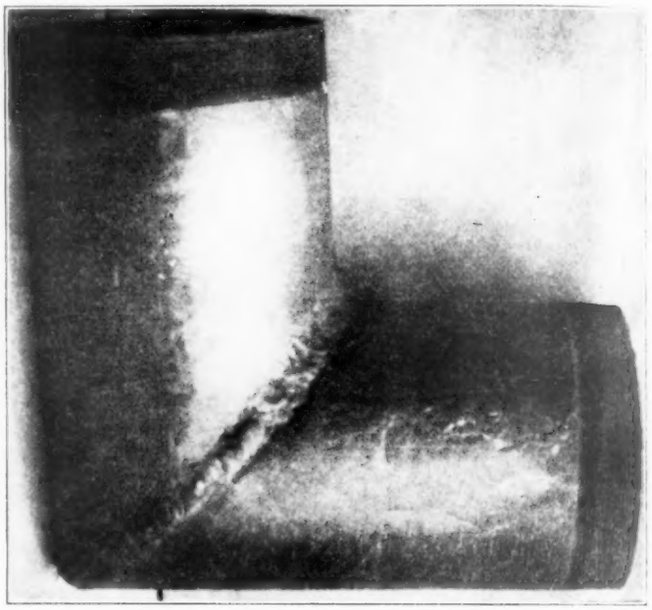

Fig. 2. Welded Pipe.

elbows and sleeves, to a few welded pipes, coupled with a limited amount of unions.

The greatest enemy of a screwed joint is vibration. The screwed joint will not stand vibration because it lacks elongation. A screwed coupling or a threaded pipe is minus elongation, because of the reduced cross sectional area at the threads. Various tension and compression tests have proven that a butt welded pipe joint has just as much elongation as an unwelded pipe, by building up the weld an eighth of an inch.

The cost of the welded pipe joint up to 2 inches is about the same as the cost of screwed connections. The cost of welded joints over 2 inches is less than the cost of cast or malleable iron connections, and the larger the pipe size the greater is the saving.

In the case of the locomotive the main point is to increase its mileage and efficiency. In order to obtain these it is necessary to decrease failures, or in other words to remove defects that may cause failures. To recover the screwed pipe connections from a locomotive as far as practicable, will be removing one of the greatest defects that caused many failures on the road.

Welding Pipes for Signal Department

On the track at interlocking stations one can see a multitude of 1¼ inch pipe lines with screwed connections. Ten years ago, these screwed connections caused so much trouble in breaking or pulling apart at the coupling, that the manufacturers decided on an improvement. Instead of applying a permanent remedy by welding the pipes together, they simply added what they called a reinforcement, by riveting the coupling to the pipes. However, this did not prevent them from breaking at the end of the threaded joints. The cost of the screwed and riveted joints is 16½ cents each. The cost of the welded joints is 12 cents.

Weld Your Sheet Metal Parts with ARMCO IRON Filler Rods

The economic saving and desirability of welded seams and fittings over the older method of riveting is now beyond question. The Electric Welding Committee of the U. S. Shipping Board conservatively estimates the saving on hull plating and other vital ship parts at 25 per cent. On minor ship parts, the labor saving is estimated to be from 60 to 70 per cent.

In the manufacture of boilers, plate shells, pressure containers, sheet metal pipe and the like, the saving in time, labor, material, the reduction in weight, etc., all indicate that welding is the approved construction for the future.

ARMCO IRON is a particularly desirable filler for welding seams of and attaching fittings to, sheet metal surfaces and containers for the following reasons:

1. Uniform purity and metal structure that produce welds of the highest efficiency and permit the standardization of repetitive welding operations with absolute reliability of the finished welds.
2. Free flow and action under heat, that make the operative's work easy and give him greater confidence.
3. The standardization of one metal composition in two tempers to meet all ordinary iron and steel requirements. ARMCO IRON rods for oxy-acetylene are the same as for electric welding except the temper, which for electric is harder to work equally well under the higher temperatures.
4. Readily obtainable in all popular sizes from conveniently located supply depots in all industrial centers.

Write for a trial shipment, and if you want free advice on welding subjects, your questions will be answered by engineers who have made welding a life study and who know from first hand experience what is being done in this line.

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Sales Offices: 30 Church Street, New York

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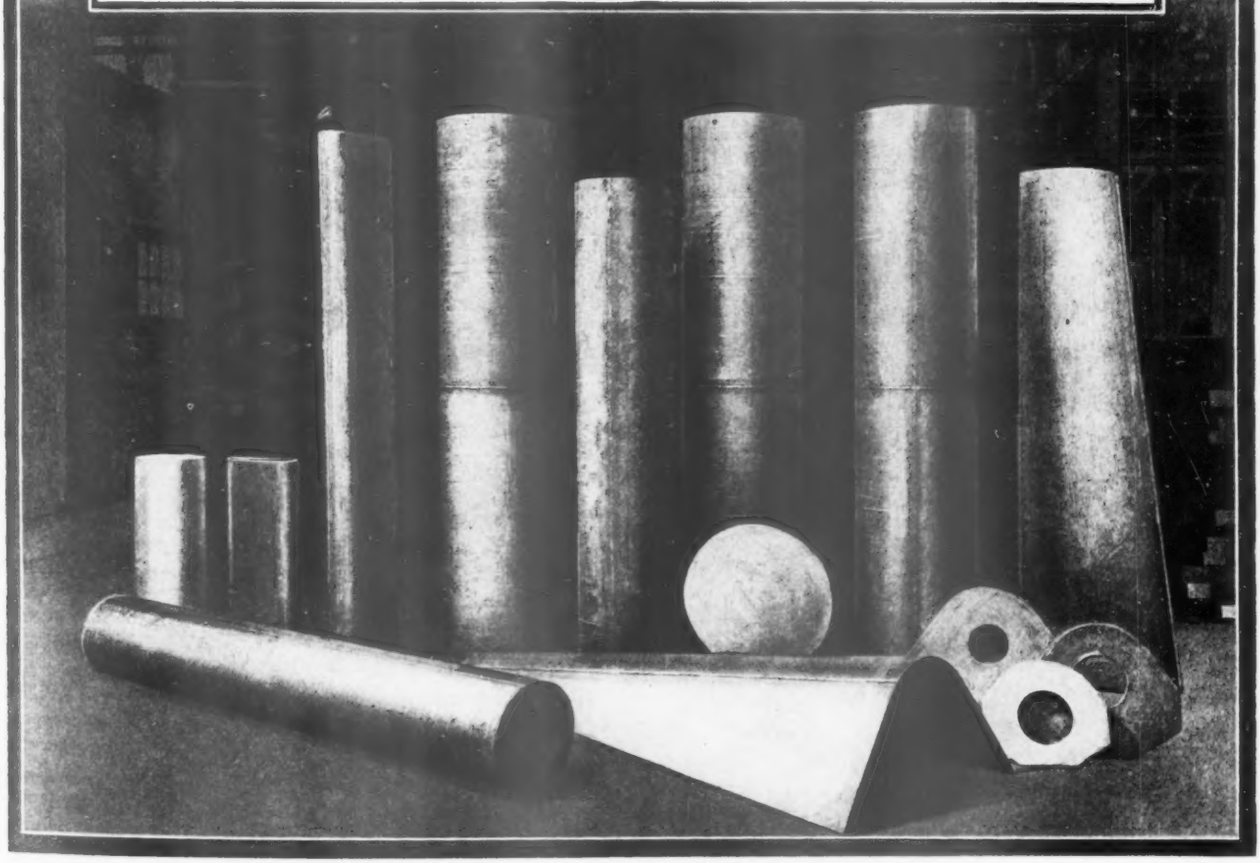


It requires two men to make up 100 screwed and riveted connections in ten hours. The welding process requires only one man to weld 120 joints in ten hours.

These pipe lines are resting on pipe carrier rolls placed about every 4 feet. The screwed pipe coupling will not go over these carriers, and in many cases it is necessary to cut off the ends of pipe so that the joints will be made ahead of the carrier. These ends that are generally a few feet long are wasted and thrown in the scrap pile. The welding process will eliminate this waste as entire lengths, minus coupling, can be operated through the carrier rolls and welded wherever it is necessary.

Commercial Pipe Welding

The next great field is commercial pipe welding. Water, oil, air, gas and steam lines can be made with welded joints, or with no joints at all, because when two or more pipes are properly butt welded together they become *jointless*.

Occasionally we hear that some engineer or contractor has decided to weld a pipe line as an absolute necessity, because the line was so placed that any future repairs were considered difficult and expensive. Although the welded pipe lines were a complete success, the same engineer or contractor would recommend the screwed connections, wherever the pipe lines are on the surface or so placed that leaks could be detected.

Before the armistice was signed a foremost plumbing contractor was engaged in the installation of heating plants for various Government buildings. However, he became short of 12-inch manifolds, tees and elbows of different degrees and being pressed to finish the heating plants, he consulted the writer for advice. The result of this was that whole steam mains were welded together and all tees eliminated. Elbows were made up of pipe and welded together with the advantage of furnishing any degree desired. Figures 1 and 2 represent two such 12-inch elbows.

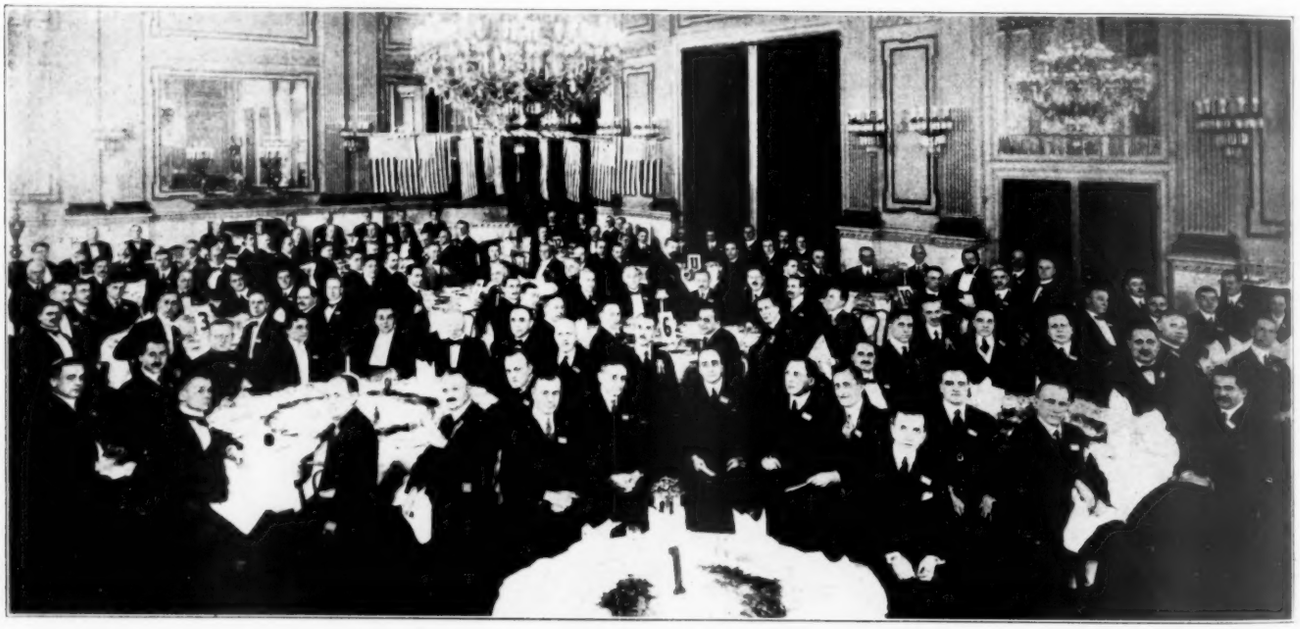
Unfortunately, the government inspector was not familiar with the merits of welded joints on pipe lines, and was inclined to reject the welding. However, the writer had made up a few welded specimens for testing purposes with the result that we proved to the inspector that the strength of the welded joints was greater than that of cast or malleable iron screwed fittings, nor was the elasticity of the pipe affected. It also proved to the inspector that the time required to lay out the pipe line for the connections, to cut and thread them and screw on the heavy tees was 50 per cent greater than that required to weld a steel sleeve or pipe to the main line, and incidentally two threaded joints were eliminated on each tee weld.

Furthermore, the contractor has experienced a saving with the welding process of 45 per cent over the cost of screwed pipe connections, with the result, that now after the war, this progressive plumber, although an old timer, has practically adapted the oxy-acetylene welding process on all large pipe lines.

ARC WELDING LIGHT SHEETS.

In a recent letter to the editor, Mr. C. B. Waters, chief engineer of the Arcweld Corporation, 42 Broadway, New York, says:

"We have welded material as light as No. 19 gauge. On light material such as this it is our practice to place a steel bar in back of the surface to be welded, so that we can use large amperage without danger of burning a hole through the work. The steel bar acts as a backing to quickly conduct the heat from the plate. On gauges over No. 12 it is perfectly feasible to weld without this backing by using a low amperage—say approximately 50. On ⅛-inch plate, we can use approximately 80 amperes. Of course, if a backing is provided, even on ⅛-inch plate, we can use much higher current and weld considerably faster. We have welded up seams on steel barrels satisfactorily."



Sixth Annual Dinner, Compressed Gas Mfg.'s Association, New York, January 20th, 1919.

ELECTRLABS.

The Electroyltic Oxy-Hydrogen Laboratories, 15 William Street, have begun in this issue an advertising campaign to reach the welding trade. Oxygen and hydrogen generating plants are the products of this company. Mr. I. H. Levin is technical director and D. J. Tonkonogy is general manager.

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The Welding Engineer

Reg. U. S. Pat. Office.

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VOLUME 4. FEBRUARY, 1919. NUMBER 2.

Women Welders

THE loss of millions of men is bound to affect the world's labor supply for a long time. Women have been utilized as welders during the war and many of them will no doubt attempt to follow the trade. They may prove successful welders on certain classes of light work; in fact, they have been welding light material successfully for several years, but we don't believe they can make any progress with heavy work.

To undertake difficult welding work, the operator requires something more than a mere knowledge of how to light the torch. Judging from the course of training given in at least one of the big munition plants the training of women welders was very meager.

At the close of the war, there were more than 3,000 women welders in the United States, but during the war we have no record of having sold a book in welding or a subscription to a woman welder. This fact would indicate a lack of a spirit of progressiveness. The man welder, no matter how good an operator he is, is hungry for information. He wants to keep pace with progress.

Doctor Welder

THE occupation of the welder is a patriotic one. He preaches conservation of energy, time, materials and money. He's the physician of the mechanical trade, the doctor who sets the broken bones. Men come to him in emergencies. Sometimes he fails, but not usually. The welder goes over the top every day and, as the military men say, he attains his objective.

Advertising the Job Shops

THE subject of advertising the job shops has been discussed before in these columns. It seems very few commercial shops give this important subject attention. The public is interested in reclamation work and in conjunction with his policy of doing good work at a reasonable price, the welder should never miss an opportunity to advertise his business. If you keep your town on the water wagon by repairing the town pump, don't fail to drop in on the editor of your local paper and remind him of it. There is one sure road to a little publicity—the country or small city editor. Give him a little ad once in a while—it works several ways.

The Welder's Future

TO the man who will go about the mastery of the art of welding in a systematic and thorough manner, the occupation of a welder offers a very promising future. Successful job welding shops have been established all over this country and their number is rapidly increasing. To be a successful job welder requires some general mechanical training, and the more of this experience the welder possesses, the more successful he will be.

The war has done a lot for the welder. For one thing, it has brought his trade, which was comparatively unknown, to the attention of millions of citizens who knew nothing about welding. The fact that welders put the German ships back in commission was in itself a big advertisement, but when Mr. Citizen was told by the local garage man that he could not use oxygen to burn out the carbon in his car, then the importance of the trade was brought home to him.

There is no danger of the welding trade being overcrowded with *real* welders. We trained a lot of men during the war, but not one-half of them turned out to be competent welders.

Instruction, study and experience are three things the welder must have. A good school for the first, books and trade papers for the second, and as for experience, we might suggest that he seeks employment under an old welder for a while.

One familiar with a railroad shop will see hundreds of defective locomotive bells recasted. In doing so a certain percentage of the tin is destroyed and replaced with new material in the crucible. The time to weld a cracked bell would be about the same as required to cast one, and no new tin would be required to replace the bell in service.

A greater saving can be obtained by welding worn out parts of brass air pump cages and application pistons for distributing valves.

Some roads are welding cracked injectors or lubricators, but when the internal threads or valve seats are defective they are sent to the scrap pile. Injectors or lubricators are now worth $100 or more each and by saving a few of these articles the saving figures could be increased considerable. Not long ago the writer noticed in a Toledo car shop three cars on a side track marked to be sent to Detroit for repairs on account of each car having a broken channel iron.

In discussing this subject with the foreman in charge he was advised that these cars had to be sent to Detroit, and there dismantled and refitted with new channel irons. This operation usually required three weeks before the cars were returned to service. The writer suggested placing two jacks under the car frames and weld the channels in place, with the result that these cars were replaced in service the same day and no new channels were used.

Some big roads that have water pan stations on the road, to scoop water in the tender, can save a great many sections, and a great deal of money by welding the joints between the pans instead of riveting. The vibration caused on the ties loosens the riveted joints, causing almost a continuous expense in maintenance, whereas the welded joints will stay solid and eliminate any further expense.

Main or side rod brasses are found in the scrap pile by the hundreds. Although they are recasted again, the tin and zinc that is to some extent destroyed by this process can be saved and broken lugs or corners can be welded at a very small expense with cast toben bronze rods.—B. K. Smith.

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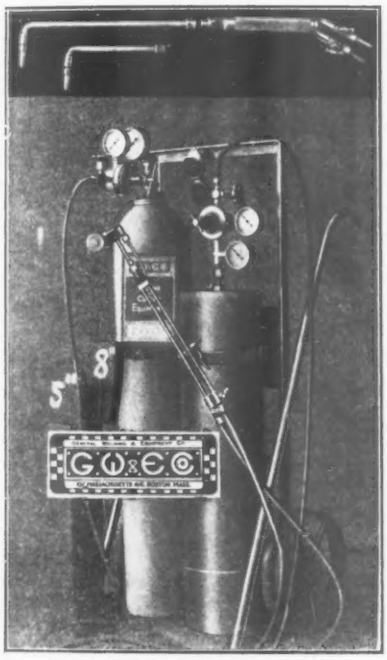
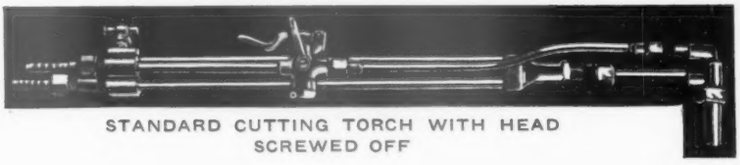
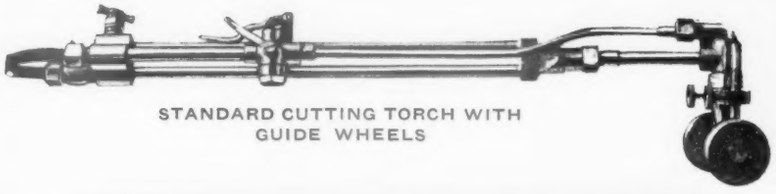


STANDARD WELDING AND CUTTING EQUIPMENT



STANDARD CUTTING TORCH WITH HEAD SCREWED OFF



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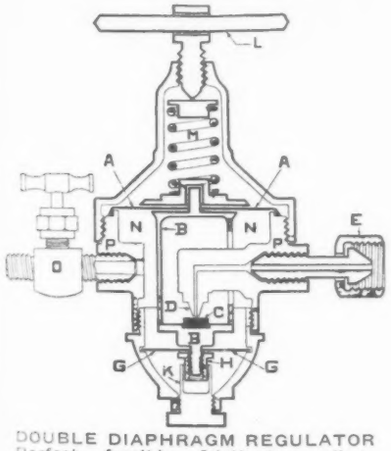
STANDARD WELDING TORCH WITH 3 EXTENSIONS, TO HAVE EITHER A 16 IN. LONG TORCH OR A 22 IN. OR A 30 IN. LONG ONE.



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   NO OTHER REGULATOR HAS THESE ESSENTIAL FEATURES.

2. WELDING TORCHES consist of a torch base with 2 extensions to have either a 16-inch long torch or a 22-inch long one, giving you practically two torches in one. A third extension may be added to have a 30-inch long torch. Thus one torch with its 9 tips is sufficient for all possible requirements.

3. CUTTING TORCHES are second to none in efficiency, economy and endurance. Everything is of the most modern open construction. Each part can be reached and inspected without delay. The picture on top shows a torch with the head separated from its base. By loosening two screws the whole head comes off, showing how easy it is to exchange even a complete head.

   MANY THOUSANDS ARE IN CONSTANT USE.

4. Everything in our constructions is easily accessible and exchangeable. By carrying a few spare parts you can do your own maintaining even in far away countries.

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INSPECTION OF STEEL ARC WELDS.

Factors Determining Their Character—Penetration and Electrical Tests—Analysis of Welds and Their Heat Treatment

By O. S. Escholz*

DETERMINING the character of welded joints is of prime importance, and the lack of a satisfactory method, more than any other factor, has been responsible for the hesitancy encountered among the engineering profession toward the extensive adoption of arc welding. To overcome this prejudicial attitude it is eminently desirable to shape our rapidly accumulating knowledge of operation into an acceptable method of inspection.

How to Determine the Character of a Weld.

The four factors which determine the physical characteristics of the metallic electrode arc welds are: Fusion, slag content, porosity and crystal structure. Some of the other important methods that have been suggested and used for indicating these characteristics are:

1. Examination of the weld by visual means to determine:
   Finish of the surface as an index to workmanship.
   Length of deposits, which indicates the frequency of breaking arc, and therefore, the ability to control the arc.
   Uniformity of the deposits, as an indication of the faithfulness with which the filler metal is placed in position.

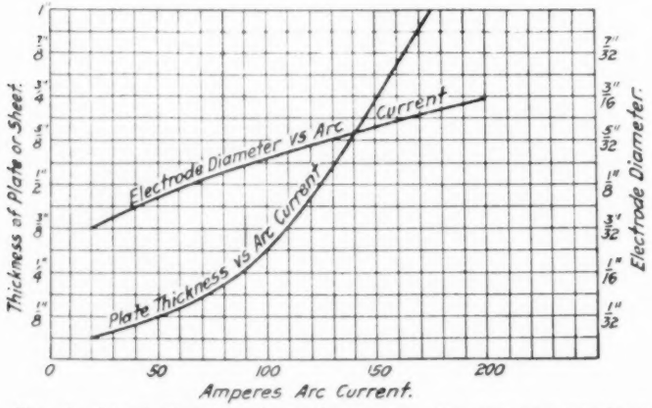


Fig. 1. Chart Showing Approximate Arc Current and Electrode Diameters for Welding Steel Plate of Various Thickness.

Fusion of deposited metal to bottom of weld scrap as shown by appearance of under side of welded joint.
Predominance of surface porosity and slag.

2. The edges of the deposited layers chipped with a cold chisel or calking tool to determine the relative adhesion of deposit.

3. Penetration tests to indicate the linked unfused zones, slag pockets and porosity by:
   X-ray penetration.
   Rate of gas penetration.
   Rate of liquid penetration.

4. Electrical tests (as a result of incomplete fusion, slag inclusions and porosity), showing variations in:
   Electrical conductivity.
   Magnetic induction.

These tests, if used to the best advantage, would involve their application to each layer of deposited metal as well as to the finished weld. This, excepting in unusual instances, would not be required by commercial practice in which a prescribed welding process is carried out.

Of the above methods the visual examination is of more importance than generally admitted. Together with it, the chipping and calking tests are of particular usefulness. The latter test serves to indicate gross neglect by the operator of the cardinal welding principles, due to the fact that only a very poor joint will respond to the tests.

*Research engineer, Westinghouse Electric & Mfg. Co., Pittsburgh.

The most reliable indication of the soundness of the weld is offered by the penetration tests. Obviously, the presence of unfused oxide surfaces, slag deposits and blow holes will offer a varying degree of penetration. Excellent results in the testing of small samples are made possible by the use of the x-ray. However, due to the nature of the apparatus, the amount of time required and the difficulty of manipulating and interpreting results, it can hardly be considered at the present time as a successful means to be used on the large-scale production.

The rate that hydrogen or air leaks through a joint from pressure above atmospheric to atmospheric, or from atmospheric to partial vacuum can readily be determined by equipment which would be quite cumbersome, and the slight advantage over liquid penetration in time reduction is not of sufficient importance to warrant consideration for most welds.

Kerosene, of the various liquids that may be applied, has marked advantages, due to its availability, low volatility and high surface tension. Due to the latter characteristics, kerosene sprayed on a weld surface is rapidly drawn into any capillaries produced by incomplete fusion between deposited metal and weld scarf, or between succeeding deposits, slag inclusions, gas pockets, etc., penetrating through the

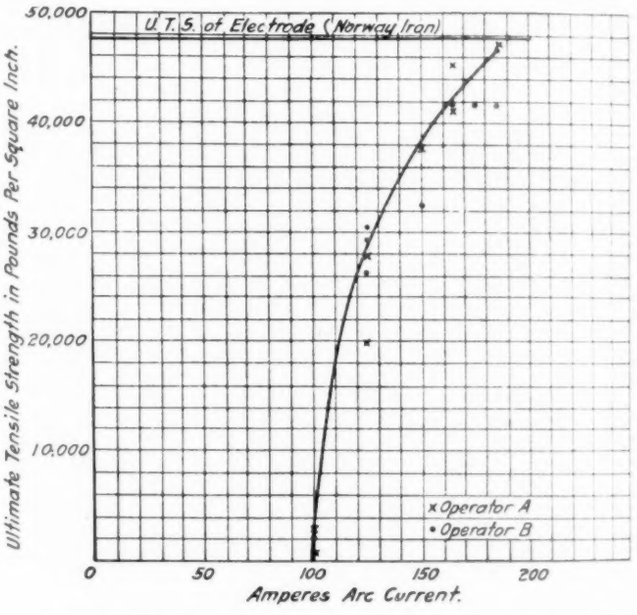


Fig. 2 Variation in Weld Strength With Change in Arc Current.

weld and showing the existence of an unsatisfactory structure by a stain on the emerging side. A bright-red stain can be produced by dissolving suitable oil soluble dyes in the kerosene.

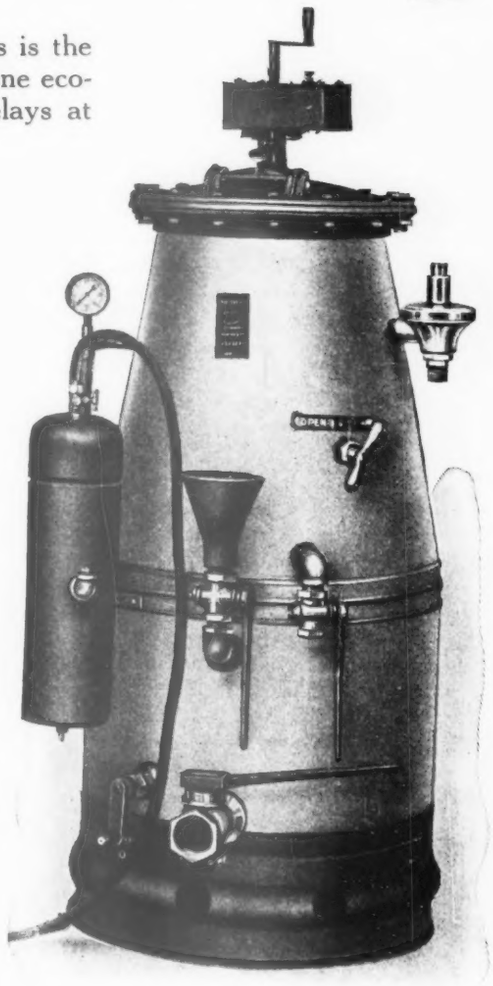
By means of this test, the presence of faults has been found that could not be detected with hydraulic pressure or other methods. By the kerosene penetration, a sequence of imperfect structures linked through the weld, which presents the greatest hazard in welded joints, could be immediately located. It must be borne in mind, however, that this method is not applicable to the detection of isolated slag or gas pockets, nor small disconnected unfused areas. It has been shown by various tests, however, that a weld may contain a considerable amount of distributed small imperfections, without affecting, to a great extent, its characteristics.

If a bad fault is betrayed by the kerosene test, it is advisable to burn out the metal with a carbon arc before rewelding under proper supervision. By means of sand blast, steam, gasoline, etc., large quantities of kerosene are preferably removed. No difficulty, however, has been encountered on welding over a thin film of the liquid.

Efficient Welding

Quick re-adjustment to peace time conditions is the imperative need everywhere. Work must be done economically, thoroughly, and with dispatch. Delays at this time, more than ever, are costly.

In **your** shop you cannot afford to depend upon acetylene in drums. This source of acetylene supply is uncertain and expensive. To depend upon drums means unavoidable delays, waste of time, loss of money. Be sure of an ever-abundant acetylene supply in your shop by generating your own acetylene with



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It produces acetylene gas at from 1/3 to 1/2 the cost of acetylene in drums. It provides a dependable supply of acetylene at all times. Your loss from delays alone, while depending upon drums, soon exceeds the cost of the Smith's Generator. Its saving in acetylene cost will pay you a handsome profit year after year.

For commercial welding the Smith will enable you to underbid your competitors who use drums, which means more business and more profit for you.

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The Smith Generator can be made to run at a range of from 3 to 12 pounds pressure. For a low pressure torch it is set at 5 pounds; for high pressure torches it can be set to deliver 10 or 12 pounds pressure. The pressure and feed of the motor are easily regulated by convenient thumb screws.

At each charging the Smith will supply approximately 140 cubic feet of acetylene gas. For most welding shops this generator will meet every requirement. Where an unusually large volume of gas is required it is practical to set up two or more of these generators in batteries and supply any desired quantity of gas. The generator can be moved on a small truck about the shop.

GUARANTEED The material and workmanship in this generator are guaranteed for a period of one year. It is made of rust-proof metal thruout. It uses 1¼"x⅜" carbide. The shipping weight is approximately 250 pounds. Price, $150.

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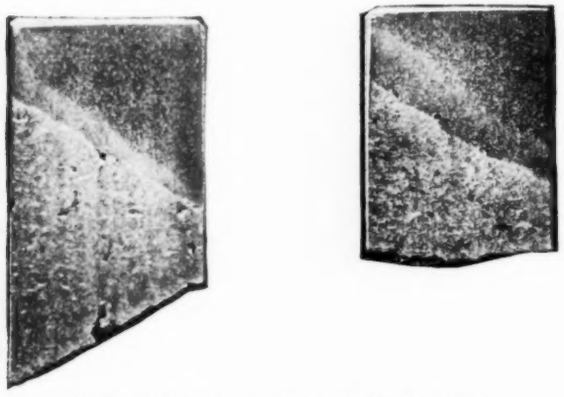
Electrical Test Method.

Electrical test methods by which the homogeneity of welds is determined, are still in the evolutionary stages. Obvious difficulties are yet to be overcome before the electrical test is feasible. Some of these are the elimination of the effect of contact differences, the influence of neighboring paths and fields, and the lack of practicable, portable instruments of sufficient sensitivity for the detection of slight variations in conductivity or magnetic field intensity. No simple tests are plausible, excepting those which involve subjecting the

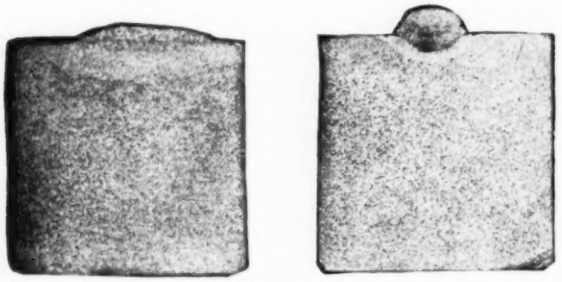


Poor Weld at Left. Good Weld at Right.

metal to excessive stresses, for determining the crystal structure. Control of this phase must be determined by the experience obtained from following a prescribed process.

The inspector of metallic arc electrode welds may consider that through the proper use of visual, chipping and penetrating tests a more definite appraisal of the finished joint may be secured than is possible in either riveting or concrete construction. The operation may be still further safeguarded by requiring rigid adherence to a specified process. Good results are assured if correct procedure is followed.

Haphazard welding can no sooner produce an acceptable product than hit-or-miss weaving will make a marketable cloth. It is only logical that all the steps in a manufacturing



Sectional View of Metal Deposited from Low Carbon Steel Electrode on Steel Stock.

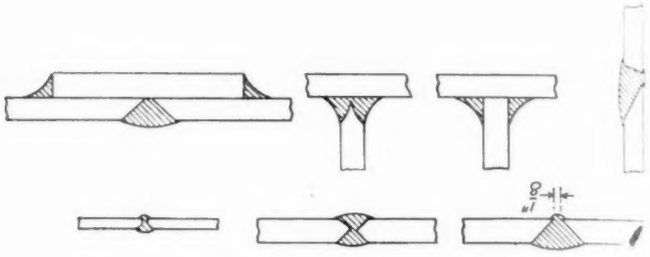
operation should be regulated so as to obtain the best possible results. As it is, and most unfortunately, most welders considers themselves pioneers in an unknown art that requires the exercise of a peculiar temperament for its successful evolution. As the result, welding operators enshroud themselves in the hallow glow of an expert and do their work with a mysterious camouflage bewildering to the untutored. Once in a while, due to, we might say, coincidences, these "experts" are successful in obtaining a good weld, but more often the good weld is attributable to the friction between slightly fused, plastered deposits.

Analysis of Arc Welds.

In common with all other operations, metallic electrode arc welding is really susceptible to analysis. Regardless of the metal welded with the arc, the cardinal steps are:

Preparation of weld.
Electrode selection.
Arc current adjustment.
Arc length maintenance.
Heat treatment.

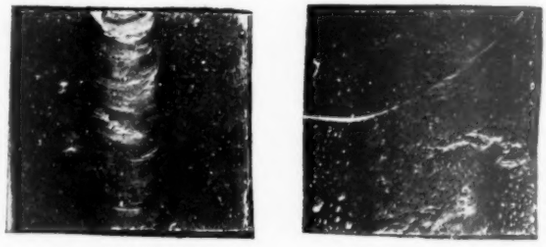
Sufficient scarfing is involved in the preparation of the weld, as well as the separation of the weld slants, so that the entire surface is accessible to the operator with a mini-



Typical Arc Weld Scarfs

mum amount of filling required. When necessary to avoid distortion and internal stresses due to unequal expansion and contraction strains, the metal is preheated or placed so as to permit the necessary movement to occur.

The electrode selection is determined by the mass, thickness and the constitution of the material to be welded. An electrode free from impurities and containing about 17 per cent carbon and 5 per cent manganese has been found generally satisfactory for welding low and high carbon as well as alloy steels. This electrode can be used for cast-iron and malleable-iron welding, although more dependable results, having a higher degree of consistency and permitting machining of welded sections, can be obtained by brazing, using a copper-aluminum-iron alloy electrode with the aid of some simple flux. Successful results are obtaining by brazing copper and brass with this electrode. The diameter of the electrode should be chosen with reference to the arc current used.



Top View of Metal Deposited from Low Carbon Steel Electrode on Steel Stock.

Effect of Too Low Arc Current Values.

A great many companies have attempted welding with too low an arc current and the result has been a poorly fused deposit. This is due largely to the overheating characteristics of most electrode holders, on using current values and thus leading the operator to come to the conclusion that the current used is in excess of the amount needed.

The approximate values of arc current to be used for given thickness of mild steel plate as well as the electrode diameter for a given arc current may be taken from the curve in Fig. 1. The variation in the strength of one-in. square welded joints as the welding current is increased is shown in Fig. 2.

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Electrodes Available Give Satisfactory Results.

Notwithstanding that the electrode development is still in its infancy, the electrodes available are giving quite satisfactory results. However, considerable strides can yet be made (with its further evolution) in the ductility of welds, consistency in results, as well as in the ease of utilizing the process.

The maintenance of a short arc length is imperative. A short arc is usually maintained by a skillful operator, as the work is thereby expedited, less electrode material wasted, and a better weld obtained, due to improved fusion, decreased slag content and porosity. On observing the arc current and arc voltage by meter deflection or from the trace of recording instruments the inspector has a continual record of the most important factors which affect weld strength, ductility, fusion, porosity, etc.

Heat Treatment and Inspection.

The method of placing the deposited layers plays an important part on the internal strains and distortion obtained on contraction. It is possible that part of these strains could be relieved by preheating and annealing, as well as by the allowance made in preparation for the movement of the metal.

The heat treatment of a completed weld is not a necessity, particularly if it has been preheated for preparation and then subjected to partial annealing. A uniform annealing of the structure is desirable, even in the welding of the small sections of alloy and high-carbon steels, if it is to be machined or subjected to heavy vibratory stresses.

The inspector, in addition to applying the above tests to the completed joint and effectively supervising the process, can readily assure himself of the competency of any operator by the submission of sample welds to ductility and tensile tests or by simply observing the surface exposed on cutting through the fused zone, grinding its face and etching with a solution of 1 part concentrated nitric acid in 10 parts water.

It is confidently assumed, in view of the many resources at the disposal of the welding inspector, that this method of obtaining joints will rapidly attain successful recognition as a dependable operation to be used in structural engineering. —The Iron Age.

THE OXY-ACETYLENE AND BLOW-PIPE EFFICIENCY.*

By Arthur Stephenson.†

When I was asked to give a paper before the members of this association my first impulse was to frame an excuse, as I should have preferred to listen to the members who are so much older, both in this association and more particularly in the industry than myself. However, I consented because I consider that it should be an obligation of membership upon every member to contribute his quota to the advancement of the industry and the enlightenment of those engaged in it.

I have selected "The Oxy-Acetylene Flame and Blow-pipe Efficiency" as the subject of this paper, primarily because hitherto the published data on this matter have been practically nil; secondly, because the flame is the essential feature in all welding operations; and finally, because all the care and skill exercised in designing and manufacturing the apparatus are centered about one object, namely, that of producing an ideal flame, and it will be for us to consider and determine upon the factors which combine to make the flame "ideal."

*A paper read before the October 10th, 1918, General Meeting of the British Acetylene and Welding Association and reprinted from The Acetylene and Welding Journal, of London.

†Engineer to the Acetylene Equipment Co., Ltd.

The introduction of some reference to the blow-pipe is unavoidable, because given conditions which are quite good for the supply and control of the gases intended for the production of the flame, the interposition of a blow-pipe which is either badly operated or designed invariably mars the results which might otherwise be obtained.

In starting out upon the consideration of the oxy-acetylene flame, let us first refresh in our minds the main accepted conditions which prevail in such flames.

Flame, as you know, results from a more or less rapid chemical action between substances, such action being generally termed—combustion.

Any such process of combustion requires a combustible and means for supporting combustion; for our purpose, acetylene is the essential combustible and oxygen the supporter of combustion.

With the oxy-acetylene flame, the oxygen is derived from two sources, namely:

1. From the prepared oxygen supply, be it trade cylinder or otherwise.

2. From the atmosphere immediately surrounding the flame.

Any specified process of combustion will yield a fixed quantity and character of products of combustion, and will evolve a definite amount of heat. Dependent upon the substances used, the heat quantity may be either of a positive of negative character, **i. e.,** may either evolve or absorb heat, but in the case of the oxy-acetylene flame it is decidedly positive, otherwise it would not receive our interest or attention.

I have said that the quantity of heat evolved during a given process of combustion is definite, but heat must not be confounded with temperature, as this latter is a distinctly variable quantity, dependent entirely upon the conditions under which the process of combustion is caused or allowed to proceed. For example, we may take the familiar case of the combustion of iron with oxygen, in which process we are all interested, and regarding which we owe much to the recent translations by Capt. Richardson from the French.

The combustion of iron with oxygen will ordinarily proceed slowly without any perceptible increase in temperature to the mass, but on the other hand, the combustion may be caused to proceed so rapidly that the temperature of the mass is increased to the point of incandescence and even fusion, yet the heat of combustion, or the amount of heat energy developed, is the same in both cases (provided of course other essential conditions apply), whilst the temperatures attained are obviously widely divergent.

I emphasize this point of heat and temperature not because I am under the impression that it is not generally known, but because it is not generally appreciated by many who operate oxy-acetylene blowpipes.

Given a definite mixture of gases, as with oxygen and acetylene, the temperature at which combustion commences is fixed, and is generally termed the "ignition point." This for the acetylene flame is regarded as being 480° C. approximately.

Provided the heat evolved during combustion is sufficient to maintain the temperature of the flame higher than the ignition point, it will continue to burn. A chemical action or process of this character being termed "exothermic." We have, therefore, to consider the oxy-acetylene flame as an exothermic chemical action, and to admit all the factors which obtain in such an action.

These are points which are, no doubt, common knowledge to all of you, but as they are points which bear directly upon the subject, I have set them out here.

Generally speaking, flames may be divided into two classes,

namely, simple and complex, and each having their distinguishing characteristics.

A simple flame, as for example, oxy-hydrogen, has but two parts, namely, the inner cone, and the outer envelope, whereas a complex flame, as with oxy-acetylene, has three distinctly visible parts, namely, the inner cone, the intermediate or luminous cone, and the outer envelope. This applies to all hydro-carbon flames.

The inner cone is non-luminous and comprises merely a mechanical mixture of the two gases, it is not so readily discernable as the others. Its dimensions depend chiefly upon the velocity of exit of the gases through the burner orifice and the dimensions of the latter, but are variable with the degree of mixing which has taken place between the gases prior to combustion, and the out of balance i. e., the difference in quantities of the oxygen and acetylene.

The intermediate or luminous cone is in the zone within which the initial chemical action takes place. It is disposed as a mantle over the inner cone of mixed gases, and its dimensions mainly depend upon:

1. The dimensions of the inner cone.
2. The relative volumes of the gases supplied.
3. The relative velocities of the two gases.
4. The conditions existing in the outer envelope.
5. The degree of mixing which takes place prior to combustion.
6. The presence of impurities in the gases.
7. The shape of the blow-pipe tip.

Its luminosity is due chiefly to the dissociation of the acetylene, and the separation of the carbon, which is raised to a temperature at which it becomes incandescent.

The degree of luminosity is slightly variable with temperature and flame pressure, but is distinctly variable with unbalanced quantities of gases and the presence of impurities.

The outer envelope of the flame results from the burning of the products of combustion from the luminous zone with atmospheric oxygen and is itself practically non-luminous.

The shape and dimensions of this outer flame are distinctly variable even for specified gas consumptions, and are partly dependent upon the conditions prevailing in the other two cones, but are also seriously affected by the matter of blow-pipe design and the conditions under which the flame is caused to operate.

There is, in fact, another portion of the oxy-acetylene flame to be noted, which comprises a non-luminous mantle around the intermediate or luminous cone. With a correctly adjusted flame and very pure gases this mantle is not easy to discern except with very large power flames, or with the aid of properly tinted glasses. It does, however, become distinctly outlined immediately prior to the flame showing an excess of acetylene, and remains visible as a dark blue mantle around the extended luminous portion of the flame which results from an excess of acetylene. It would appear to be the zone within which the formation of the products of the first chemical action occur and that there exists at this point superheated carbon monoxide and hydrogen, both capable of further oxidation. The admission of impurities or the out of balance of the gases, both of which serve to slow up the rate of combustion have the effect of enlarging the dimensions of this non-luminous zone and making it more pronounced in the flame.

The actual conditions which prevail in practice vary very largely, due to many causes; it is, therefore, only possible to represent the chemical actions which take place in a correctly proportioned flame which is perfectly neutral, and wherein the consumption of oxygen is equal to that of acetylene. These we shall regard as the desirable conditions for good practice.

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Electric welding has become so important an art in the mechanical industries that a comprehensive treatise on this subject covering both the resistance and the arc welding processes is needed in the trade. A special study of the subject has, therefore, been made by the authors of this work, who have been assisted in their work by the experts in resistance and arc welding of some of the most prominent concerns in the United States engaged in this line of work.

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CONTENTS

Electric Welding Processes—Electric Resistance Butt-Welding Special Butt-Welding Machines and Processes—Electric Spot-Welding—Seam-Welding and Riveting—Percussion Welding—Electric Soldering—Principles of Electric Arc Welding—Applications of Electric Arc Welding—Welding Transformer Tanks by Electric Arc.

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It is usual to consider the combustion of acetylene as being completed in two distinct stages, but it will be obvious that the transitory reactions are more numerous.

The first stage, which for our purpose we shall term the high temperature action, is represented in ordinary chemical formula by the expression—

$$C_2H_2 + 2O = 2CO + H_2$$

Acetylene + Oxygen = Carbon Monoxide + Hydrogen.

In tracing this stage of the process we have the following conditions:

Combustion is started by the application of extraneous heat to the mixture of gases issuing from the blow-pipe orifice. This applied heat must be capable of raising the temperature to that of the "ignition point," which is at least 480° C., whereupon further heat is developed by combustion so as to raise the temperature in excess of 780° C., at which point the acetylene is capable of dissociation into its constituents, carbon and hydrogen, with the liberation of heat energy, *i. e.*, heat of dissociation. This heat value is substantially the same as that absorbed in the formation of acetylene and is equivalent to 58 Calories (approx.).

According to various authorities, the major portion of this heat is absorbed by the carbon upon liberation, so that its temperature is raised beyond that at which it becomes incandescent. This accounts for the familiar luminosity of the intermediate or luminous cone previously referred to.

There exists at this stage a mixture of hydrogen, oxygen and carbon, all raised to a temperature considerably in excess of the normal, due to this heat of dissociation.

It is well known that where gases are preheated prior to combustion, the temperature attained is considerably in excess of that which obtains under normal conditions; for example, we might refer to blast furnace work. This also applies with the combustion of acetylene, except that the heating effect is far more concentrated, due to the dissociation of the acetylene actually occuring in the flame. It is this point, due undoubtedly to the endothermic nature of the acetylene which gives to this flame its phenomenal advantage over other similar flames.

The next phase is that of combination between the carbon, now raised to incandescence and the oxygen in the mixture for the formation of carbon monoxide (CO). The hydrogen is at this stage inoperative, for the supposed reasons that the chemical affinity between hydrogen and oxygen is less than that which exists between carbon and oxygen, also that the prevailing temperature is in excess of that at which hydrogen and oxygen can combine. The hydrogen, therefore, passes forward into the second stage, but at a comparatively high temperature.

The combination of the carbon and oxygen yields a further quantity of heat energy, termed the heat of formation; this takes place round the fringe of the luminous or intermediate cone, and is probably responsible for the non-luminous zone previously referred to. The rate of combustion is obviously exceedingly rapid, as evidenced by the dimensions of the non-luminous zone, and is undoubtedly accelerated by the endothermic nature of the acetylene. The time factor between dissociation and the formation of the carbon monoxide is indicated by and may be deduced for comparative purposes from the dimensions of the luminous mantle which surrounds the inner cone of mixed gases. This is a matter which, as a whole, has an important bearing on the flame in practice. See Graph. 3, which gives normal length of cone for specified consumptions.

Up to this point the quantity of oxygen required is not in excess of the quantity of acetylene, and it is obvious that where in actual practice it is necessary to pass through the blow-pipe an excess of oxygen, it is rather to compensate for conditions other than those which may be regarded as essentially thermo-chemical.

We have as products of the first stage of combustion hydrogen and carbon monoxide, both of which are capable of further oxidation and development of heat.

The second stage, which we shall term the low temperature action, is expressed in chemical formula as—

$$2CO + H_2 + 3O = 2CO_2 + H_2O.$$

Carbon Monoxide + Hydrogen + Oxygen = Carbon Dioxide + Water (Vapor).

In this there are, in fact, two chemical actions, namely, the oxidation of the carbon monoxide and of the hydrogen occuring simultaneously, but both developing further heat by their heats of formation. These actions are less rapid or concentrated than the former, and the resulting temperature much lower. The heat developed, however, serves to cloak the previous action and to preserve its heat from ready dissipation.

The foregoing remarks make no reference to the source from which the oxygen required for the low temperature reaction is obtained, but as this is atmospheric oxygen and its extraction from the atmosphere involves the liberation of a proportionate amount of nitrogen (see Table I), the major portion of which passes through the flame, there is a consequent loss in heat due to its absorption by the nitrogen. Although the presence of nitrogen serves other useful functions in welding operations which are not within the scope of this paper, the fact that it serves to reduce the temperature of the operating flame is an apparent disadvantage.

Table I.

	Volumes Required.		Volume before Combustion.	Volume of Nitrogen.	Volume after Combustion.	Total Contraction.	Percentage Contraction
Oxygen	2.5		3.5	0	3.0	0.5	14.3
Oxygen	1.0	}	9.2	5.7	8.7	0.5	5.44
Air	7.2	}					
Air	12		13	9.5	12.5	0.5	3.85

The whole question of the calorific value of aceytlene and the factors which serve to limit it, is one deserving of more detailed attention than can be given in this paper. Perhaps the *Committee* will be able to prevail upon some member to deal thoroughly with the subject at an early date.

Whilst it is absolutely correct to state that the heat of combustion is a fixed quantity, yet when other factors are admitted into the flame, such as chemical or gaseous impurities, water vapor, or an excess or paucity of either essential gas, it is obvious that the calorific value must be reduced.

Mr. Bingham, in his recent paper read before this Association on "Impurities in Acetylene," clearly showed the effects of diluents.

The figures given by various authorities for the calorific values do not agree, and it is apparent that the differences are due to the varied conditions under which the determinations were made.

You will appreciate that it is one matter for a manufacturer to prescribe the conditions necessary to obtain desirable results, but it is another matter to be able to control the conditions which obtain in practice. There are many factors which operate to vary the conditions under which combustion proceeds in practice; not least amongst these is that of the human element, namely, the operator, who has it in his power at all times to make or mar the results. In many cases, whilst desiring the former, he actually effects the latter, due largely to lack of knowledge as to the "cause

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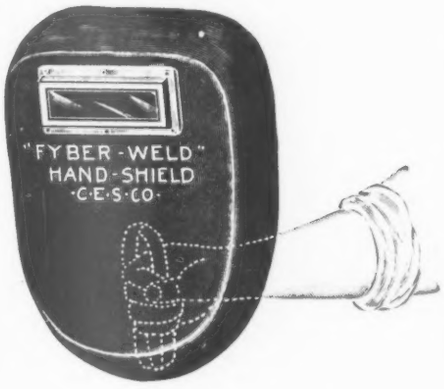

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and effect" of the blow-pipe flame conditions or due to force of circumstances, such as overworked and badly operated generators or plant, inefficient purification, and badly designed plants which, unfortunately, we cannot entirely rule out, for even in these enlightened days one meets with manufacturers who disclaim even the need of any purifier with low pressure welding plants.

The figure given for the heat of combustion of acetylene is 315.7 calories, which is the heating effect as measured in large calories per gramme-molecule.

The figures given for the calorific value or the heating effect per cubic feet consumed at N.T.P. vary from 320 to 410 calories, but from more recent determinations the higher figure is apparently more nearly correct. The following factors seriously govern the heating value per unit volume consumed:

1. The temperature and pressure of the gases prior to combustion.
2. Their relative temperatures to each other.
3. The temperature and pressure of the products of combustion.
4. The degree of purity of dryness of the gases.
5. The gas proportions in the flame, with which is connected the efficient mixing prior to combustion.

It is known that in any case of combustion, the heating effect, or the calorific value, is at its maximum when the quantities entering into the chemical action are balanced, and where no uncombined gases or diluents capable of absorbing heat remain present after combustion.

In the case of the flame from high pressure gases, wherein it is not difficult to realize best conditions set out in the points enumerated above, and where the flame is allowed to burn in air at ordinary temperature and barometric pressure, the calorific value may be taken in round figures as 400 calories. In the case of low pressure blow-pipes which operate on the injector principle and where the degree of mixing is more variable, temperature of acetylene higher, and degree of purity and dryness probably less than with high pressure it is to be expected, that the calorific value will be below the figure stated.

The importance of utilizing gases of the highest degree of purity at the lowest possible temperature, and the avoidance of any excess of restriction of either oxygen or acetylene in the flame is self-evident.

The main features governing the temperature of the flame are those which govern the calorific value, therefore the values which have been variously estimated, and the figures given in catalogues and other publications for the temperature of the oxy-acetylene flame obviously cannot agree. These vary from 2000° C. to 4000° C., but these two figures are undoubtedly extremes. In my opinion, and from my experience, I should say that the temperature of 4000° C. is unobtainable in ordinary practice, whereas the temperature of 2000° C. can only prevail in bad practice.

Whilst it is impossible to fix temperatures without having fixed conditions, it is to be expected that given good apparatus and pure gases in balanced quantities, the temperature existing in the flame attains 3000° C. (5432° F.) but does not exceed 3500° C. (6332° F.).

The factors which have the effect of retarding the rate of combustion and of absorbing heat in the flame have also the effect of reducing the resulting temperature. Further, there should be no misconception about the fact that under proper working conditions the temperature of the work under the influence of the flame is not that which exists in the flame itself. It may be repetition, but it may be useful to set out the main conditions which limit the temperature of the flame:

1. The gas consumption in respect to section of work below normal requirements.
2. Impurities in the gases which retard the rate of combustion and increase the volume of products (*vide* Mr. Bingham's paper previously referred to).
3. Out of balance in the quantity of gases consumed.
4. Respective velocity of exit of gases from the blow-pipe orifice.
5. Insufficient mixing in the blow-pipe prior to combustion.
6. Dimensions of the outer envelope which are dependent upon the amount of atmospheric oxygen consumed by the flame.
7. In complete combustion, which very often takes place where a blow-pipe is caused to operate in a confined space, whereto the free access of air is difficult, as, for example, welding the interior of a motor car cylinder.

Numbers 3 to 6 inclusive may be bracketed together, as upon these depend very materially the rate of combustion and, what is more important, the complete combustion of all combustible matter in the flame.

Incidentally, in regard to No. 7, and the troubles of the blow-pipe backfiring when welding in confined spaces to which the supply of air is restricted, it is quite a common thing to condemn the blow-pipe, or to attribute the trouble to overheating the blow-pipe tip, but a little thought given to the question of complete combustion and free access of the necessary air will, in most cases, result in removing the blame entirely from the blowpipe.

It has been possible to demonstrate this on more than one occasion by introducing into the confined space, which in one particular instance in mind was that of a very small diameter cylinder, an independent supply of air which entirely removed the trouble of backfire and increased the rate of welding very considerably.

In order that the highest temperature may obtain in the flame, the combustion must be completed at its highest possible rate, and must yield a minimum volume of products in relation to the initial volume of the mixture.

It is accepted that for complete combustion the proportionate volume of oxygen to that of acetylene is 2.5 to 1; also that the essential oxygen is in part obtained from the atmosphere, and by a happy compromise it is possible, within limits, to make this source supply the balance required over and above the amount passed through the blow-pipe. Graph 2 shows the corresponding amounts of air and oxygen required to complete the combustion of unit volume of acetylene.

It is generally admitted that the ideal conditions prevail when the amount of oxygen fed into the blowpipe is equal in volume to that of acetylene (the essential conditions as to temperature, pressure and degree of purity being understood).

Manufacturers at the same time state that for this and that blow-pipe the best conditions obtain when the oxygen consumption is in excess of the acetylene consumption. This excess varies with types of blow-pipes from 0.2 to 0.8 volumes.

The questions which immediately suggest themselves are:

A. Why this excess?
B. What happens to it?
C. What are the results of it?

In reply to question A, it is obvious that the excess is not required to complete the high temperature chemical action in the flame, of which I have previously made mention; it is also obvious that on a point of economy it would appear better to consume a maximum volume of atmospheric oxygen with a corresponding reduction in the volume passed through the blow-pipe.

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(To be continued)

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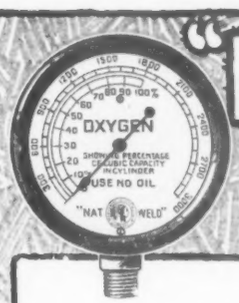

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An association has been launched at Portland, Ore., called the "Burners, Welders and Helpers Union of America." Headquarters are at 234 Worchester Bldg., Third and Oak Streets.

The Northwestern Welders' Association, of Minneapolis, had an exhibit at the auto show, February 15.

The National Welding Council and the Welding Committee of the Emergency Fleet Corporation, have been merged into the American Welding Association, with offices in New York. It is understood a large sum of money will be raised to advertise the utility of welding and to carry on experimental work.

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"Electric Arc Welding" is the title of a new book published by the Lincoln Electric Co., Cleveland, Ohio. It consists of 75 pages of very useful information and interesting illustrations. Ten lessons in arc welding are included.

"A Short Course In Oxy-Acetylene Welding," by Alfred S. Kinsey, is being published by the Air Reduction Sales Co., New York. Mr. Kinsey is professor of Shop Practice at Stevens Institute of Technology and organized and directed a special war course in oxy-acetylene welding and cutting at the Twenty-third Street Y. M. C. A., New York. This book is intended for schools and colleges.

"Repair of the German Ships," is the title of a book published by the Wilson Welder & Metals Co., Inc., 2 Rector Street, New York. This is a story of the damage to and quick repair of German liners taken over at the time the United States entered the war.

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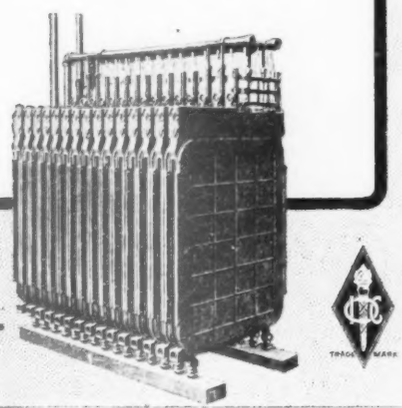

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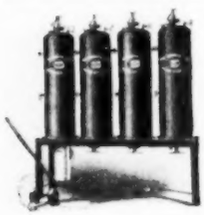

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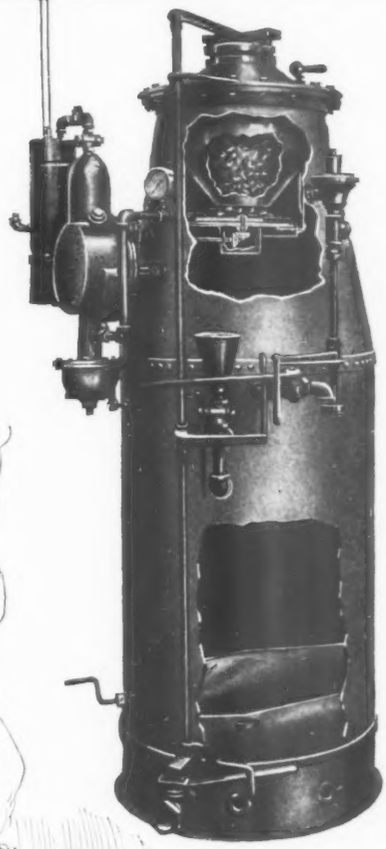
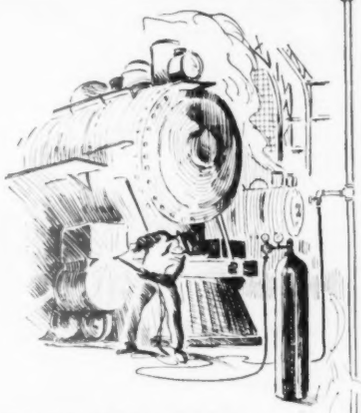


AIRCO

GENERATORS



CAN BE OPERATED
IN ONLY ONE WAY—

THE RIGHT WAY

AIRCO GENERATORS are on the approved list of the National Board of Fire Underwriters.

AIRCO GENERATORS are of the carbide to water type and use $1\frac{1}{4}x\frac{3}{8}$ inch carbide, assuring a maximum gas yield and low even generation without pressure fluctuation. Because of the AIRCO type of feed, the carbide is evenly distributed over the surface of the water in the generating chamber, preventing localized heating of the water and insuring cool gas of a high quality, which can be obtained only under these ideal conditions.

WATER MOTOR

The generation of acetylene is regulated by means of a water motor, which is operated by the gas passing through it to the service pipe.

There are no clock work, springs, or weights to get out of order.

AIR REDUCTION CO., INC.

120 BROADWAY, NEW YORK CITY

DISTRICT OFFICES

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BALTIMORE, MD., 546 E. Monument St.
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BUFFALO N. Y., 730 Grant St.
CHICAGO, ILL., 2236 So. Lumber St.
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CLEVELAND, OHIO, 1219 W. 69th St.
DEFIANCE, OHIO, Squire Ave.
SAN FRANCISCO, CAL., 179 First St.
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